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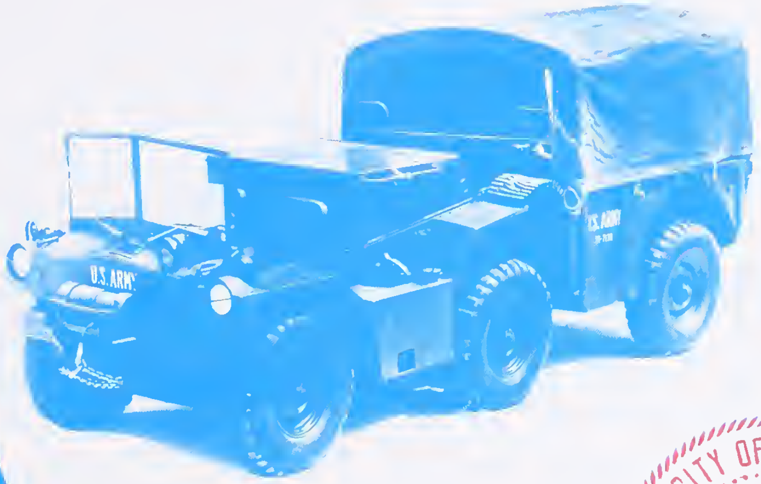

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Comment

The Editorial Staff

Can one take a step forward by taking a step backward? The *Defense Management Journal* thinks so.

Periodically every organization should step back and attempt to view itself objectively to see whether its course is still true, or whether any changes or adjustments are required. That's precisely what the *Journal* has recently done; as a result, some major changes are planned beginning in January 1978.

As noted in our last issue, the *Journal* is discontinuing theme-oriented issues. In their place will be a modified departmental concept wherein major subject areas such as manpower and personnel, logistics, and research and development will be represented in every issue. This revised coverage will provide readers with a more diverse selection of management articles in each issue.

Three other significant changes are also programmed. The first concerns frequency of publication. Responding to a progressive demand from readers, the *Journal* staff has decided to commence bimonthly publication. The ultimate goal is to provide readers a timelier, sooner-read and passed-on *Journal*. Naturally, this increase in frequency will be accomplished without any degradation of product quality.

The second change deals with audience-level focus. Because a large portion of our readership now consists of middle managers, the *Journal* will include a variety of articles targeted to that level. There will be articles dealing with theory and policy, plus practical management operations and practices. However, this will infringe neither the specific informational needs nor allegiance of senior management.

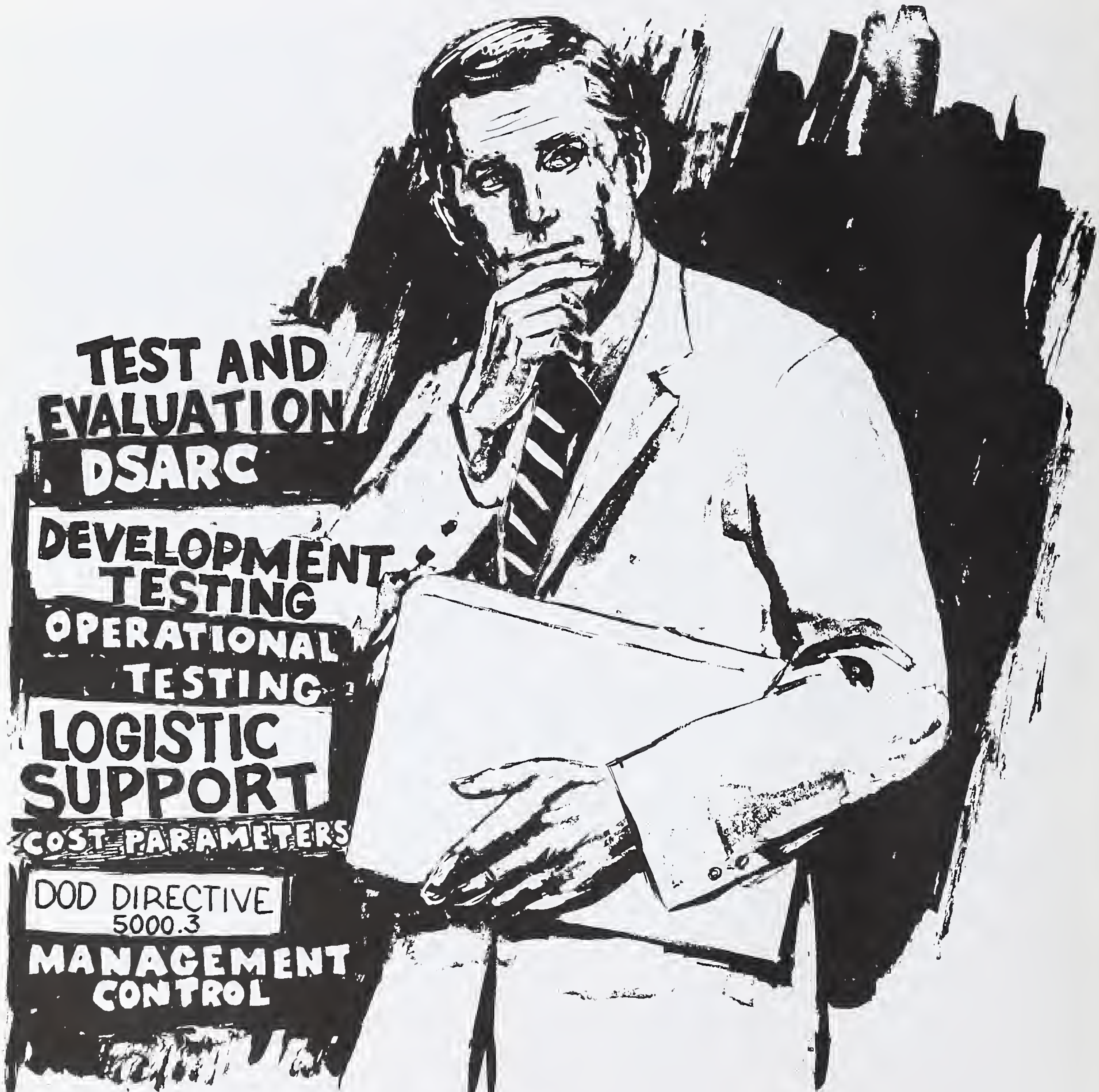
The third change relates to the reader's efficient use of time. The latest *Journal* readership survey statistics (see the April 1977 *Journal*) implied that the higher the grade, the less time spent on reading. Indeed, we recognize that defense managers are constantly faced with an avalanche of written matter and not enough time to read all of it. To ameliorate this situation somewhat, the *Journal* will provide brief article abstracts as part of the table of contents. These abstracts will enable readers to select quickly which articles they want to read in full and those they want only to scan.

All of these innovations are a logical response to the changing demands of our readers. In making them, however, the *Journal* is mindful of its responsibility to those who have been faithful readers for years and like the magazine the way it is. They can rest assured that the *Journal* will continue to address the key management trends, issues, policies, and operations that concern managers and decisionmakers. The *Journal* will continue to function as an active and viable medium for the interchange of ideas and techniques for management improvement. There will be no retreat from the commitment to timely, in-depth coverage, nor any less concern for an appealing layout and complementary graphics.

As we noted in our report on the 1976 readership survey, to thrive as a vital and stimulating publication, we need to hear from all segments of our audience from time to time. Particularly because we are making the aforementioned changes, your criticisms, opinions, and insights relative to the *Journal's* contents are all the more important. In broadening our scope, are we including the subjects you want to read about? Or do you perhaps disagree with a new policy directive? The Feedback section of the magazine is the place to construct just such a dialogue with your fellow managers. But your input is obviously the critical ingredient.

When it was established ten years ago, the *Journal* was a unique DoD publication treating management improvement with the attention it deserves and portraying management as an art and science. This is still the role the *Journal* seeks to fulfill, only more often in the coming months and years. **DMJ**

Reducing Risk Through Testing



Properly applied, test and evaluation can guide managers to the best system at the most affordable price.

When a separate test and evaluation function was formed within the Department of Defense in 1971, there were dire predictions of additional management layering, a stretchout of the acquisition cycle, increased costs, insignificant benefits, and other adverse effects. There were few proponents.

If there was truly no value to be gained by this move, why was T&E formed as an independent activity? To find the answer, it is necessary to go back to the President's Blue Ribbon Defense Panel Report of 1970.

The Presidential panel made a number of recommendations designed to improve the Defense Department's overall operations. Particularly concerned with the acquisition process, it recommended abandoning total package procurement and avoiding unnecessary concurrency in weapon system programs between the development and production phases. The panel also noted the operational test and evaluation efforts of DoD and the military services, and concluded that the results were spotty and generally ineffectual. Particularly pertinent to this discussion was the specific recommendation that an organization be formed that would report directly to the Secretary of Defense, would be at a level above the services, and would ensure that operational test and evaluation was productively accomplished and the results utilized effectively in the acquisition process.

by Rear Adm. L. S. Kollmorgen, USN
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In arriving at this recommendation, the panel reviewed several weapon system case histories. The M-16 rifle was perhaps the most widely publicized and typified the motivation underlying the panel's thinking.

During the Vietnam conflict, the M-16's performance had come to the attention of Congress as a result of letters sent home by soldiers complaining about the rifle's propensity to jam. The reviewers found that the M-16 had gone through several modifications subsequent to approval of the original design without a complete field test of the effect of those modifications. The original design had received a complete checkout in development tests. However, it turned out that even the relatively simple design of the M-16 was subject to variations in performance, because design changes in one portion adversely affected other elements. This led to serious malfunctions in combat.

The panel observed that operational testing had a direct relationship to the military capabilities of the operating forces. Therefore, it concluded that operational testing required continued, high-level emphasis.

In any large organization which expends large sums for acquiring and maintaining systems and equipment, there is a requirement to make decisions that take into consideration alternative solutions. The selection of an alternative is facilitated if adequate T&E is conducted and results are available for review.

The DoD T&E program has two primary objectives:

- Determination of essential operational characteristics of new weapon systems.
- Evaluation of their operational effectiveness and suitability when they are utilized in a realistic environment.

The DoD executives who make acquisition decisions must consider the relative risk that some element of the program might produce an unintended result which could adversely affect system effectiveness, cost, or availability for deployment. These executives have come to depend on the results and assessments of valid tests as inputs to their risk estimates.

Besides being essential for decision making, test and evaluation contributes in other ways. Developmental testing and evaluation, for example, is an integral part of the process by which a system design is converted into hardware, the hardware tested, deficiencies noted, and the design modified as necessary. This process is iterated until the system hardware reaches a design configuration considered adequate to fulfill specified objectives. DT&E provides the system designers with essential and verifiable feedback information that would be difficult or impossible to obtain from purely analytical processes.

As noted in the M-16 example, operational testing has a direct relationship to the military capabilities of operating forces. The greater the effort made to identify and correct any operational deficiencies discovered before the design of a system is frozen, the greater will be the capabilities of the operating forces when the new weapon system is deployed. Furthermore, significant cost and time benefits may be realized if major system deficiencies are found and corrected prior to either quantity production or operational deployment. Certainly it is less disruptive to such essential activities of operating forces as training, tactics development, and maintaining a high state of operational readiness, if extensive in-service fault correction and retrofits can be avoided.

In effecting the testing policies set forth in DoD Directives 5000.1, "Acquisition of Defense Material," and 5000.3, "Test and Evaluation," it is sometimes difficult to reconcile the guidance that stems from different points of view. For example, concern has been expressed over the ponderous nature of the developmental process and the potential impact on the nation's military capability. Those voicing this concern view test and evaluation as a contributing factor to what they perceive as the excessive length of the acquisition process, and conclude that items needed in a hurry must be removed from the process in order to get the job done on time.

On the other hand, others feel that the process moves too fast and are disturbed by the pressure applied to get systems into production before development has been completed.

One of the more misinterpreted catchwords used in connection with test and evaluation is "fly before buy," which is often associated with the policies formulated by former Deputy Secretary of Defense David Packard. It has been variously interpreted, and is perhaps the cause of the more pejorative comments connected with operational test and evaluation. This results from the misperception of initial operational testing as a major hurdle to be overcome prior to receiving production approval. This is not and has never been the intention in requiring adequate OT&E before making the major production decision.

Reducing Risk

What Mr. Packard was advocating was sound program planning with the achievement of key development objectives validated through test and evaluation, and the provision of adequate time in the development and early production period to allow for the correction of deficiencies brought to light in developmental testing and OT&E. The intention was to reduce the risk of unpleasant surprises and costly corrections to deployed equipments through increased emphasis on adequate, as well as operationally relevant, testing.

A successful transition from development into production is not characterized by an abrupt termination of development followed by an immediate start of production. Rather, it is a gradual process by which the production effort is phased in as the development effort is phased down, but not necessarily out. Testing should be continued throughout this transition period to provide input to the production engineering effort and contribute to the maturing of the weapon system design.

The key is selecting the appro-

priate point to start the transition. Ideally this would be when a system's design and technology are well in hand and the government will benefit from the most advantageous application of investment dollars. In short, it requires an assessment of the risk involved in initiating production balanced against the need for acquiring the military capability. Of course, this implies the exercise of sound judgment.

Unsatisfactory Results

The policy contained in DoDD 5000.3 has not been in existence long enough to have influenced a major weapon system throughout the acquisition cycle; that is, from initiation through production. It may be useful, however, to review some experiences that have been gained during the period the directive has been in effect.

For a variety of reasons, some programs have suffered severe delays or have produced results far short of the intended goals. The causes have ranged from insufficient testing, to testing

Firings of operational POSEIDON missiles after development revealed less-than-optimum performance levels.

which discovered deficiencies too late, to adequate testing which pointed out shortcomings but failed to influence decisions for adequate corrective action before production began.

For example, in the Encapsulated Torpedo (CAPTOR) program, an insufficient number of initial test articles prevented early determination, within acceptable probability bounds, of the causes of the inadequate performance observed in testing. The result was a deferral of the major production decision until follow-on T&E of pilot production items could be conducted. This is sometimes referred to as the T&E gap, which can be avoided by planning for sufficient test articles and adequate OT&E. Provision for such activity is necessary to bridge the transition from development to initial production. It also provides for a higher degree of assurance that lessons learned from the testing and incorporated into the early production items will preclude unpleasant surprises in production systems.

In the case of the Navy's HARPOON anti-ship missile, the engineering prototypes completed a successful developmental test program. However, operational tests of pilot production models disclosed failures in missile components which rendered reliability unacceptable. The failures developed when the transition was made from essentially handcrafting missiles to building them with production materials, tools, processes, and personnel. The initial, low-rate production was maintained until the problems were resolved and solutions verified by additional operational testing. This illustrates the desirability of early quality assurance tests, the need to be prepared to make required changes in materials and processes, and the value of a planned period of pilot production and testing to bridge the transition to full production.

After the POSEIDON missile was deployed in 1971, scheduled firings of operational missiles indicated that the missile was not maintaining the performance level demonstrated during developmental tests. Investigation determined that the degradations in performance were attributable primarily to the lack of adequate component testing and screening during production rather than to the missile design, which had been verified in the developmental program. To correct this, the POSEIDON Modification Program was initiated at a cost of more than $200 million, and the subsequent performance of the missile improved as a result of changes made to production processes. This illustrates the validity of continued operational testing to ensure that no degradation in desired performance is induced by production methods or the operational environment.

When a program has provided for adequate testing in the appropriate environments and test results warn of problems, the warning must be heeded. In this way, situations similar to that of the Army's GAMA GOAT might be avoided. The GAMA GOAT is a 1¼-ton truck designed to transport cargo, personnel, and weapons both on and off roads in military operations.

Even though prototype testing in 1966 indicated that the GAMA GOAT would not be suitable for military use until several modifications had been made and tested, the vehicle was approved for quantity production. Following 1967 tests in which reliability requirements were not met, a decision was made to procure more than 15,000 vehicles.

Testing in 1969 on preproduction vehicles revealed maintenance and durability problems, and in 1970 the first 11 production vehicles were rejected because of quality control defects. Production continued, however, and GAMA GOAT was deployed despite high maintenance requirements, poor durability, and indications that the Army did not have a satisfactory combat vehicle.

Early Correction

As mentioned previously, early detection and correction of deficiencies can result in more capability in the operating forces and less likelihood of costly retrofit programs.

A good example of a recent

Although prototype and preproduction testing of the Army's GAMA GOAT revealed problems, production of the truck continued.

case where T&E revealed a system deficiency at an early stage was the crew-escape system designed for the B-1 bomber. Tests conducted with the B-1 crew-escape module at Holloman Air Force Base, New Mexico, demonstrated that the system's aerodynamic stability could not be assured at speeds above 300 knots per hour. Extensive redesign involving high risk and additional cost would have been necessary to provide that stability. Development of the module was therefore terminated, and an off-the-shelf ejection-seat system is being modified to replace the crew-escape module.

In yet another example of the value of T&E in detecting system defects, the Navy discovered during tests of the prototype CH-53E helicopter that the main rotor shaft had a low fatigue life, requiring replacement after only 230 hours because the contractor had underestimated the dynamic flight loads the shaft would have to sustain. As a result of these tests, a redesigned main rotor shaft with a fatigue life of 11,000 hours was fabricated and will be fully tested and subsequently installed in the production aircraft.

During the early 1970's, emphasis was placed almost exclusively on conducting OT&E just prior to the major production decision, Defense Systems Acquisition Review Council Milestone III. This was because of the large procurement funding commitment usually implicit at Milestone III. Lately, however, it has been realized that earlier OT&E may be beneficial for four reasons:

- In considering system concepts during the early stages of a program, it is necessary to know not only whether they are technically feasible, but also whether they are operationally viable or tactically useful.

- To have any impact on the R&D phase of a program, OT&E must be conducted earlier than immediately prior to DSARC III, since by then the major portion of the research and development resources are usually expended.
- The earlier in the development cycle a deficiency is identified, the less will be the cost of corrective action.
- The successful completion of early and operationally valid testing reduces the risk in the long-lead release and limited production decisions.

Indications are that a better field product is resulting from emphasis on early operational testing. The early field demonstration of desired reliability goals in the UTTAS helicopter illustrates this. At program initiation, DoD placed strong emphasis on UTTAS reliability objectives by establishing realistic preliminary reliability goals and rules for reliability measurements. These goals were met or exceeded during operational testing by Army troops, providing increased confidence that the production reliability goal would be achieved in the operational environment. Currently, DoDD 5000.3 is being revised to reflect this emphasis on earlier operational testing.

Reliability

Another area in which T&E is now making a significant contribution is that of equipment reliability. This is not a new field of interest; the services have long concentrated on it and have given close attention to achieving improved reliability through proper design and quality control in the production process. T&E plays a major role in the measurement of reliability and isolation of failures. The actual correction of defects is accomplished for the most part by redesign of the equipment or improved quality control in its manufacture.

Laboratory and bench tests of components and assemblies are the mainstays of reliability testing by the contractor, and form the basis for proving that his equipment complies with specifications in his contract. What these tests do not do is expose the system to the full range of operational stresses, the harder handling of less-well-trained military operational and maintenance personnel, and the cumulative effects of harsh field conditions.

If these reliability weaknesses are to be discovered before they adversely affect a large number of deployed equipments, the equipment must be tested under typical operational conditions. Therefore, the services are now required to specify reliability requirements in operational terms, measurable under operational conditions.

A limiting factor in operational testing is that of obtaining a sufficient number of hours of system operation under relevant conditions; that is, full system operation in an actual field environment. These are costly hours. To augment them, it is necessary to ensure, to the greatest extent possible, that developmental testing of new systems is done under conditions sufficiently realistic that the failure data can be combined with the results of operational testing to give a comprehensive, yet more economical, method of evaluating weapon system reliability.

How Much Is Enough?

Although T&E makes a valuable contribution to the weapons acquisition process, it is important to ensure that testing is not conducted unnecessarily. There is obviously some point at which the incremental value of information obtained by additional testing is not worth the additional expense. The factors which influence the judgment about how much testing is needed vary from program to program.

The T&E policy changes emphasizing earlier operational testing, operationally valid reliability goals, and combined developmental and operational testing are expected to improve the efficiency of the acquisition process in general. Specifically, the greater emphasis on earlier operational exposure to systems under test should provide in-

The Navy's HARPOON anti-ship missile successfully completed developmental testing, but operational testing disclosed failures in missile components.

creased confidence that weapon systems so tested will have the desired operational characteristics upon deployment. In addition, the weapon design teams should profit from timely feedback of the results of operationally significant tests.

The requirement to set preliminary reliability goals specified in operationally relevant terms should go far toward producing equipment that meets the users' needs. Hopefully, reliance on statistical projections will be reduced.

A closer association of developmental and operational testing should provide for decreased costs of tests, schedule improvements, and more emphasis on operationally relevant testing. As a result, decision makers should have more and better information on which to base their judgments, and increased knowledge of any inherent risks.

Of course, these are the objectives desired. Only people can make things happen, and only through continued dialogue can we ensure that the true intent and objectives of DoD policies are understood. DMJ

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Admiral Kollmorgen's naval career began over 32 years ago. He has held numerous assignments of increasing responsibility including duty as Deputy Chief of Naval Operations for Air Warfare; Special Assistant to the Director, Navy Program Planning; Commander of Cecil Field Naval Air Station; and prior to his current assignment, he was appointed as Military Assistant to President Ford.

Admiral Kollmorgen is a graduate of the U. S. Naval Academy.

Tailoring Specifications and Standards To Today's Needs

Specifications and standards have too often been treated more as sacred documents than as practical, workable guidelines.

What's wrong with military specifications and standards? Why have these documents been criticized over the years by the defense industry, program managers, and military users? Both Congress and the General Accounting Office have condemned specifications and standards as sources of poor performance, goldplating, excessive delays, and unnecessary costs. But is the real problem the documents and the way they are written, or is it the way they are used?

All responsible organizations, whether involved in commercial or government operations, must utilize specifications to some degree. Together with standards, they represent a readily available library of accepted design, assembly, test, inspection, and management techniques which are known consistently to produce quality products. When properly prepared, they prevent "reinvention of the wheel." Specifications and standards are, by far, the most effective means available for communicating requirements between the customer and the seller, and as such are essential procurement instruments. Why, then, have they been so maligned?

DSB Task Force

In July 1974, at the request of the Deputy Secretary of Defense, the Defense Science Board created a task force on specifications and standards to answer these specific questions. With representation from the Office of the Secretary of Defense, the three military departments, the Defense Logistics Agency, and industry, the task force had as its primary objective the development of recommendations for improving the origination, generation, maintenance, and application of specifications and standards.

The members began by evaluating the conclusions, recommendations, and implementation of recommendations developed from previous acquisition and standardization program

by Lester Fox
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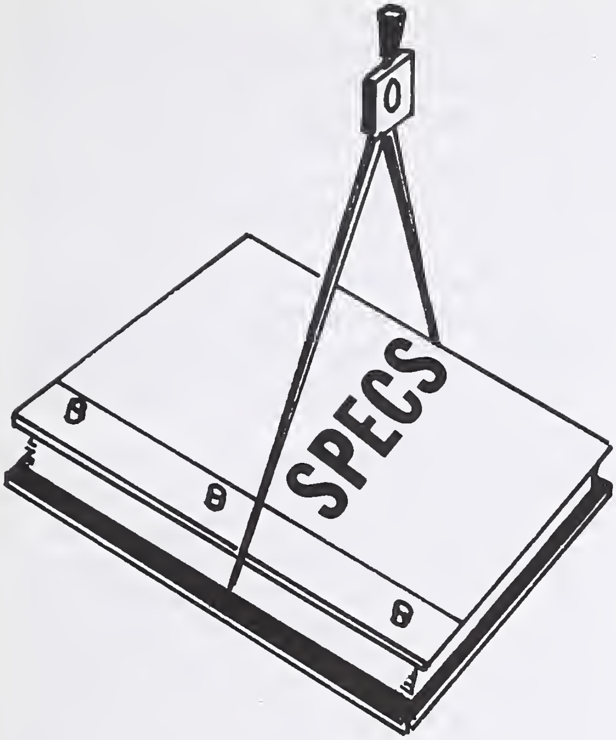

studies.[1] Unreasonable specification requirements cited in many of these studies were examined and then discussed with government and industry managers. The task force evaluated a sampling of current Department of Defense specifications and standards, related DoD organizational structure, application practices, and feedback mechanisms, and reached the following conclusions:

- Specifications and standards are essential tools in the DoD procurement process.
- Although not perfect, the existing body of military specifications and standards adequately satisfies the needs of DoD.
- The climate surrounding the application, interpretation, and enforcement of specifications and standards needs immediate improvement.
- Certain categories of specifications and standards, either by their structure or misuse, display a tendency to drive contract costs unnecessarily. These documents are typically non-end-item oriented in that they define procedural techniques.

The study found that although some improvement in the substantive content of military and federal specifications and standards was possible in all areas, the benefits derived from such improvement would not be as significant or achievable in the near term as those which could be achieved from an improved climate of application. Specifically, the task force determined that excessive costs arose when the specifications and standards imposed on a contract required change by contractors from their accustomed and proven methods of doing business; were given their most stringent interpretations; were too rigidly or prematurely applied in the acquisition cycle; were input-oriented rather than objective-oriented; were applied without limiting incorporation by reference of lower-tier documents called out in the top-level documents; or were used in a climate requiring excessive demonstration of compliance through prescribed procedural approaches. Misuses included misapplications, overapplication, underapplication, untimely application, and misinterpretation.

Unnecessary Requirements

Although the structure and layout of specifications and standards sometimes contributed to their misapplication, investigation revealed that the flexibility and levels of applicability written into specifications and standards were consistently ignored, resulting in inappropriate, excessive, and costly contract requirements. Specifications and standards were treated as if they were sacred. Contractors and government managers were found to be equally at fault, but for different reasons.

Government managers responsible for generating requirements took great pains to avoid the risk of failure, often going to extremes to preclude that risk; while contractors were constrained by the pressures of a highly competitive marketplace to comply indiscriminately with requirements even when those requirements were obsolete, redundant, or not cost-effective. In most cases, little analysis had been

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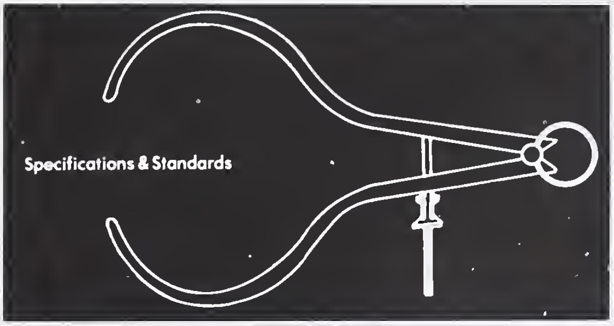
[1] *U. S. Bureau of the Budget, "Review of the DoD Standardization Program," Washington, DC, December 14, 1961; Logistics Management Institute Report, "The Department of Defense Standardization Program," Washington, DC, November 1963; Defense Advisory Council, "Recommendations for Specifications Simplification," January 11, 1964; U. S. Congress, House, "Military Supply Systems: Cataloging, Standardization, and Provisioning of Spare Parts," Congressional Record, p. 91-1,718; Assistant Secretary of Defense (I&L), "DoD Standardization Study," February 22, 1972.*



done to evaluate the costs of certain specifications as opposed to their benefits. The result was a tendency toward an overly conservative and unnecessarily expensive application of military specifications and standards.

Of the more than 40,000 documents catalogued in the DoD Index of Specifications and Standards covering both hardware and management subjects, the task force determined that nonhardware specifications and standards had the greatest potential for misuse. Typically, in addition to improving the potential for quality performance, specifications serve as a primer of good management practices for the inexperienced. Many of the military's management standardization documents, however, required contractors to develop a set of procedures (for quality control, reliability, or configuration management, for example) different from acceptable procedures already established within their organization.

"Specifications are, by far, the most effective means available for communicating requirements between the customer and the seller, and as such are essential procurement instruments."

Based on these findings, the task force recommended a twofold approach to improve the climate for applying specifications and standards. First, it advocated increased emphasis on tailoring requirements to specific system needs prior to contractual application. Specifications and standards reviews, for example, should be conducted by the government prior to issuing the request for proposals. During these reviews, attention should be focused on ensuring not only that all facets of the program are adequately addressed, but also that only the most appropriate documents are selected and only their essential requirements invoked. Contractors should be encouraged to propose cost-effective alternatives to government requirements. In concert with the design-to-cost philosophy, contractor flexibility should be promoted and encouraged.

"Although not perfect, the existing body of military specifications and standards adequately satisfies the needs of DoD."

The second recommendation was to strengthen top-level DoD management of specifications and standards. The task force concluded that closer management attention should be aimed at controlling the format, content, and proliferation of those specifications and standards that had the greatest potential for misuse. Improved feedback mechanisms should be developed to couple specification preparers with government and industry specification users. New specifications and standards should be structured to facilitate their tailoring.

DoD Actions

As a result of the task force's findings, the Deputy Secretary of Defense instructed the Defense Materiel Specifications and Standards Office and the military departments to review and evaluate the process of establishing technical requirements for inclusion in RFPs and contracts.[2] Specific emphasis was to be placed on assuring coordination and interaction among the contributing technologies in those areas known to have a high potential for generating costs. In addition, the Deputy Secretary directed that these organizations should:

> *Institute procedures and policies to control blanket contractual imposition of such specifications and standards. These controls should be structured to force technical activities to tailor requirements to the essential, specific, operational needs of the end item equipment or system.*[3]

Meanwhile the military departments took

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[2] *Deputy Secretary of Defense Memorandum, August 4, 1975, subject: Specifications/Standards Application.*

[3] *Ibid.*

steps to improve the application and tailoring of specifications and standards. The U. S. Army Development and Readiness Command, the Chief of Naval Material, and the Air Force Systems Command established procedures and issued instructions to their subordinate commands for conducting, reviewing, and reporting tailoring activity.[4,5,6] Concurrently, the Armed Services Procurement Regulations were revised to mandate the tailoring of specifications and standards (ASPR 1-1201(a)) and the feedback of contractual changes affecting specifications and standards (ASPR 1-1201(e)).

> **"The concept of tailoring contractual requirements to satisfy system requirements is not new. It is basic, good management."**

DMSSO also initiated a series of briefings with heads of the various system commands to review their methods of implementing specifications and standards application policies. A program of on-site visits and discussions was initiated with the DoD components and program managers to determine the degree to which the services were implementing the new policies and to view first-hand the difficulties that were encountered.

The information gained from these visits and other related activities made it evident that policies governing the application and tailoring of specifications and standards should be more clearly defined and specific responsibilities assigned to DoD components and program managers. Consequently, on April 9, 1977, DoD Directive 4120.21, "Specifications and Standards Application," was issued. This directive requires all DoD components to establish specific, continuing management controls over the utilization of specifications, standards, and related technical data in the acquisition process to assure that they are properly applied and tailored to reflect the minimal, essential requirements for the particular system. In addition, the new directive specifies that existing management review boards assure that tailoring is accomplished, that records are maintained as to the degree of tailoring accomplished, and that feedback is requested from potential contractors during the solicitation stage.

Tailoring Philosophy

The concept of tailoring contractual requirements to satisfy system requirements is not new. It is basic, good management. At the outset of any new defense system development program, it is not practicable to define and describe all technical requirements down to the last detail which ultimately will be required for production of the system. The development of the definitive detail into the system specification is a progressive, evolutionary process which continues throughout the development and into the production phases of the program. At every major milestone in program development, reviews are conducted to ensure that all aspects of system requirements have been or will be adequately addressed. All military specifications and standards which enhance the success of the program are incorporated into the system specification and associated statement of work.

> **"Certain categories of specifications and standards, either by their structure or misuse, display a tendency to drive contract costs unnecessarily. These are typically non-end-item oriented in that they define procedural techniques."**

In the past, this evolutionary process focused on military specifications and standards as a whole unless major deficiencies were found within required standardization documents. The detailed challenge of individual requirements to detect redundant, unnecessary, or untimely demands contained within essential specifications is typically not addressed.

The current DoD emphasis on specifications and standards not only expands upon previous practices but focuses on specific, formalized tailoring and application. This involves four

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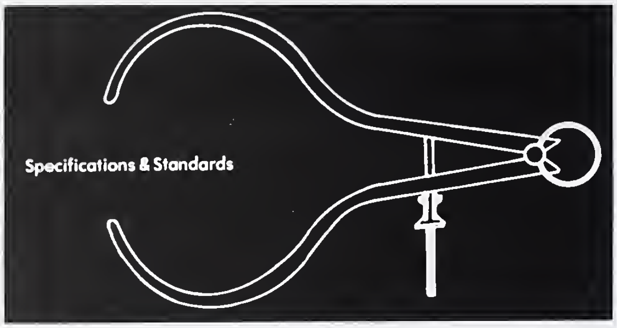
[4] *U. S. Army Materiel Command Letter, September 25, 1975, subject: Elimination of Nonessential Contractual Requirements of Specifications and Standards in RFPs and Subsequent Contracts.*

[5] *U. S. Naval Material Command Letter, October 7, 1975, subject: Specifications and Standards Application.*

[6] *U. S. Air Force Systems Command, AFSC Regulation 800-25, "Application of Military Specifications and Standards to DoD Procurements," June 12, 1975.*



basic steps (Figure 1). A degree of caution must be exercised in achieving the desired balance between performance and life cycle cost. While it is essential that specifications and standards be applied in a prudent and cost-effective manner, essential operational capability requirements must not be sacrificed.

The process described is particularly applicable in the selection and use of nonproduct specifications and standards in a given materiel acquisition program. On the other hand, product specifications such as those for parts, material, components, and equipments are not as susceptible to tailoring when selected for use in a materiel acquisition, since they have been developed around a specific set of design or performance characteristics. The process of tailoring the requirements contained in the product specification would normally be accomplished during the development and promulgation of the document, independent of a specific acquisition program. For that reason, the decision regarding the use of product specifications in materiel acquisitions is normally a matter of adopting it in full or rejecting it completely. This does not mean that product specifications cannot be tailored for use in a particular acquisition program; they can and should be when conditions warrant such action.

Improving Control

The investigation conducted by the Defense Science Board task force highlighted the need for closer management attention on controlling the format, content, proliferation, and application of nonproduct specifications and standards. The defense standardization program is commodity-oriented and defined by federal supply classes. The noncommodity-oriented standardization documents (those not fitting within specifics FSCs) had been somewhat neglected, resulting in overlapping, repetitive documentation and voids. To correct this problem, the task force recommended that a comprehensive, top-level management program be initiated which would identify specific management standardization areas; integrate all ongoing projects in these areas together with their objectives, schedules, and required resources; and define future necessary projects and requirements for improving documentation control.

The task force developed an initial listing of nine DoD standardization areas needing immediate attention (Figure 2).

> **"The current DoD emphasis on specifications and standards not only expands upon previous practices but focuses on specific, formalized tailoring and application."**

In December 1976, the Defense Materiel Specifications and Standards Office assigned to various lead-service activities the centralized management responsibility for developing DoD program plans to accomplish interservice standardization of appropriate documents. For each of the assigned areas, the lead-service activities are required to prepare, coordinate and provide DMSSO with a five-year standardization documentation program plan to:

- Identify existing military documents and related data item descriptions.

Figure 1. Basic Steps in Specifications Application

- Selecting those documents that may have application to a particular acquisition program.
- Identifying from these the ones that have specific application.
- Tailoring each document to include only the minimum necessary requirements in the solicitation or contract.
- Specifically tailoring these requirements to support the particular system during acquisition and life cycle ownership.

- Assess the status of these documents with respect to current military requirements and the state-of-the-art.
- Highlight voids in document requirements.
- Plan for deleting unnecessary requirements, eliminating duplication, and consolidating specifications, standards, and related documents.
- Restructure and develop specifications and standards for cost-effective application.

DMSSO also expanded the list of areas needing improved management attention. These included such nonproduct-oriented disciplines as nondestructive testing and inspection, thermal joining of metals, soldering, electromagnetic compatibility, and long-haul communications. A reliability standardization document program plan was approved by the Defense Materiel Specifications and Standards Board, and draft program plans were developed for nearly all of the remaining areas.

> **"While it is essential that specifications and standards be applied in a prudent and cost-effective manner, essential operational capability requirements must not be sacrificed."**

In conjunction with the emphasis placed on restructuring specifications and standards to make them more conducive to selective application and tailoring, the concept of sectionalization was introduced. In simplest terms, this promotes the construction of standardization documents to simplify the tailoring process by specifically grouping all mandatory requirements, specifically identifying optional requirements, ranges, variables, and the like, and structuring each requirement to be independent of any other requirement in the document. The purpose and objective of each separately structured requirement are defined together with a statement of how it should be utilized in acquisition programs. This sectionalization approach has been utilized successfully on such documents as MIL-STD-202, "Test Methods for Electronic and Electrical Component Parts," and MIL-STD-810, "Environmental Test Methods," and the expansion of the concept and its application to other standardization areas is being fostered.

Figure 2. Standardization Areas Requiring Management Emphasis

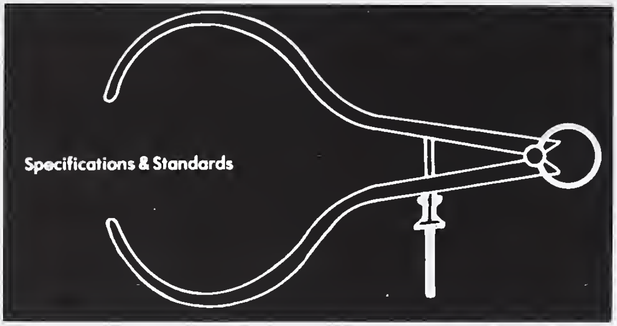
- General design requirement specifications.
- Environmental requirements and test methods.
- Reliability and maintainability.
- Quality control.
- Human factors and safety.
- Documentation.
- Configuration control.
- Integrated logistic support.
- Packing, packaging, preservation, and transportation.

Program Assessment

Results from major defense system reviews conducted by the DMSSO have been encouraging. Because of the DoD emphasis on specification tailoring and selective application, flexibility provisions were incorporated into the solicitation and contractual packages for major acquisition programs such as the Navy's Electronic Warfare Suite and the Army's Single Channel Ground and Airborne Radio Subsystem (SINCGARS) and Advanced Attack Helicopter programs.

Competing contractors for the EW suite and the AAH were provided with considerable design latitude during the development of their system specifications. In issuing the RFP for the prototype EW suite development contract, the Naval Electronics Systems Command clearly specified mandatory operational performance requirements. Many of the military specifications and standards cited in the statement of work, however, were provided to the contractors to be used as technical guidelines. In a similar vein, the AAH competing contractors were encouraged to submit waivers, deletions, and alternatives to specifications and standards cited in the government-prepared system specification which the contractor felt were cost-effective and appropriate.

The SINCGARS program extended the specifications and standards flexibility provisions to include contractual latitude in the submission of technical data. Offerors were requested to propose alternative data items, cross-referenced to stated requirements, with justification and



cost estimates for the Army Electronics Command's evaluation.

Progress is clearly being made in improving the climate of specifications and standards application, tailoring and control. A comprehensive program has been initiated to control and coordinate requirements cited in management-oriented documents. The gulf between specification preparers and specification users is being narrowed. Flexibility, judgment, and contractual latitude have been introduced in the application of specifications, but there is still room for significant improvement. The leadership of managers at all levels is needed to educate and motivate both government and contractor personnel in the continued, cost-effective development and application of specifications and standards. DMJ

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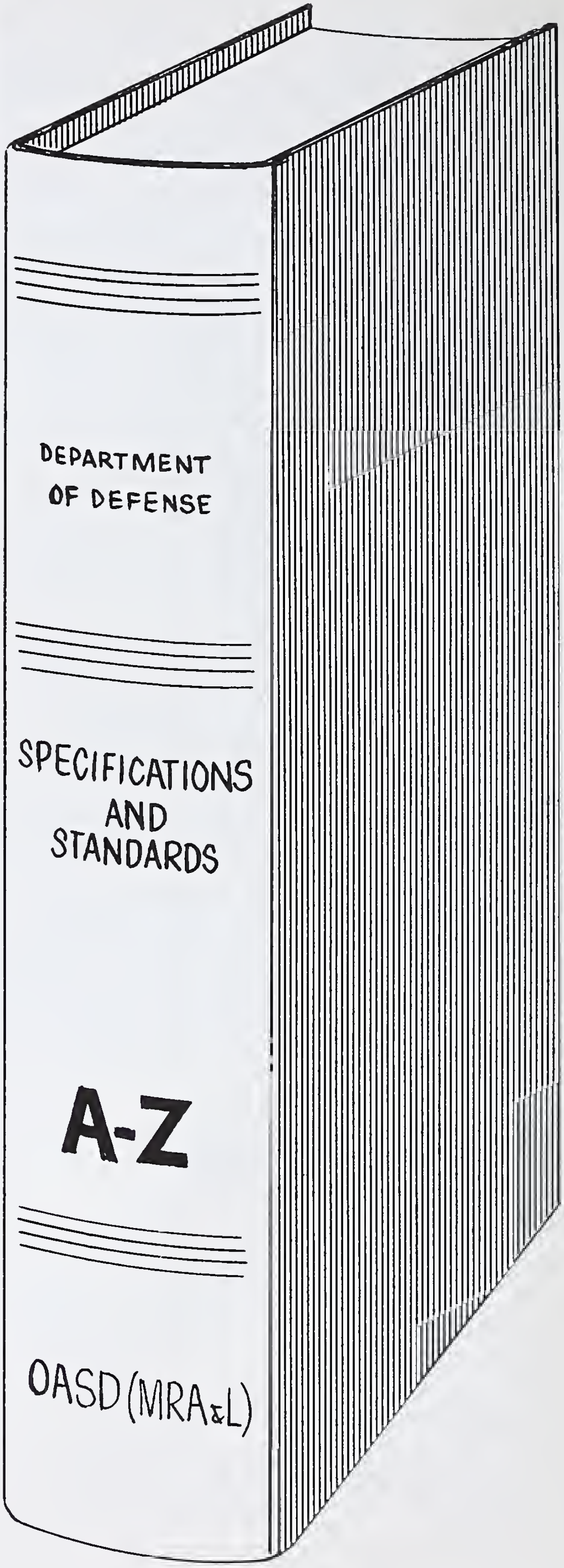

Operational Influences on Avionics Reliability

Despite the much-publicized horror stories about avionics equipment unreliability, the average level of the field operational MTBF achieved for Air Force avionics equipment is 51 percent of that required by contract when compared by the same failure definitions and time base.

Experience has shown that the reliability performance of U. S. Air Force avionics equipments in the field does not generally agree with the predicted or demonstrated values. In recent years logistic support costs of such equipments have become increasingly prohibitive; hence, an increased interest in identifying the causes of the differences, as well as a requirement for better predictive methods for estimating field operational reliability.[1,2,3,4]

An underlying principle connecting the required, predicted, and demonstrated mean time between failure of avionics equipment is that each index attempts to measure the same parameter; namely, the inherent reliability of the equipment. Certainly some disparity among these indices is expected due to the different procedures that are employed to generate them.

The required MTBF is established by consideration of mission requirements, costs, previous experience, and so forth. The predicted MTBF is an analytical assessment of the inherent reliability based on equipment design characteristics, while the demonstrated MTBF assesses inherent reliability on the basis of the failure and operating-time experience of a specific sample of equipment under controlled laboratory test conditions. The field MTBF, on the other hand, is an assessment of the achieved operational reliability of the equipment in actual operation.

In principle, therefore, the four indices should be reasonably alike since they are measures of the same parameter. In practice, however, it

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Opinions expressed herein ore those of the outhor and not necessarily those of the Department of Defense.

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1. S. Miller et al., "Research Study of Radar Reliability and Its Impact on Life Cycle Costs for the APQ 113, –114, –120, and –144 Radars," ASD–TR–73–22, Aeronautical Systems Division, Wright-Patterson Air Force Base, OH, April 1973.

2. B. Swett, "Avionics Reliability Study-Phase II," Air Force Systems Command, Andrews Air Force Base, MD, March 1974.

3. A. Burkhard et al., "Environmental Effects on Reliability and Maintainability of Air Force Avionics Equipment," AFFDL–TR–74–113, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, OH, August 1974.

4. J. Nelson et al., "A Weapon-System Life-Cycle Overview: The A–7D Experience," Headquarters United States Air Force, Washington, DC, October 1974.

has been reported that the ratio of equipment's demonstrated MTBF to its field MTBF can range from 7 to 1 to 20 to 1.[5] Even greater disparities are quoted when comparing predicted MTBFs to field MTBFs.

In view of the foregoing, a study of operational influences on reliability (OIR) of avionics equipment was sponsored by the Air Force Systems Command. The OIR study examined a broad cross section of Air Force avionics equipments in order to assess the differences in MTBFs and to identify the significant operational factors which influence the reported disparity.[6,7] In general the view taken is that any reasonable disparity may be attributed in the main to either definitional factors, operational factors, or environmental factors.[8,9] This study has shown that after removal of the definitional factors, about half of the remaining differences are accounted for by operational factors and the remainder are due to the combined influence of environmental and other factors.

The scope of the OIR study covered the first two factors and included 16 different avionics equipment items in current operational use on 10 different aircraft weapon systems. Since many of these equipments were used on two or more different weapon systems, a total of 30 different applications (combinations of equipment and weapon systems) were included in the study. The resultant avionics population provided a good representation of the four major avionics functions and an opportunity to observe operational performance of the same equipment on different types of aircraft or in different mission environments.

MTBF Assessment

A good deal of confusion has been generated by inconsistencies in the criteria used for assessing field operational MTBF. These inconsistencies result from differences in definitions used, for example, for such things as time or failure. In the Air Force Logistics Command's product performance assessments, weapon system flying hours, rather than equipment operating hours, are used as the time base.[10] Hence, equipment operating time accrued during ground operation or during operational checkouts and maintenance is not included. This is in conflict with the operating-hours time base used for requirements, prediction, or demonstration test assessments. Similarly, the criteria used by AFLC for classifying maintenance actions as failures include many items which would not be counted as relevant for reliability assessment purposes. The reason for these differences in failure criteria stems from the fact that the AFLC assessments are logistics resource impact-oriented (logistics MTBF) and not inherent reliability (mission success)-oriented. In the latter case, externally caused failures (broken, bent, loose, missing, cracked, and so forth) are normally counted as nonrelevant failures for inherent reliability assessment, but as failures for AFLC assessment purposes, since they impact on logistic resources.

Field operational reliability performance assessments were based on analysis of Air Force maintenance data using the standard AFLC product performance assessment methods, adjusted as appropriate to ensure consistency in the time base and failure criteria used for assessment.

The composite effects of the differences in criteria used for field reliability assessment are shown in Figure 1. The graph illustrates, for each of the 16 different avionics equipment items studied, the field MTBF ratios achieved as

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[5] *A. Burkhard et al., "Environmental Effects."*

[6] *The work described in this paper was sponsored by the Air Force Systems Command, Rome Air Development Center, Griffiss Air Force Base, NY. The authors are grateful to Mr. Eugene Fiorentino, the technical monitor, for his constructive guidance during the study.*

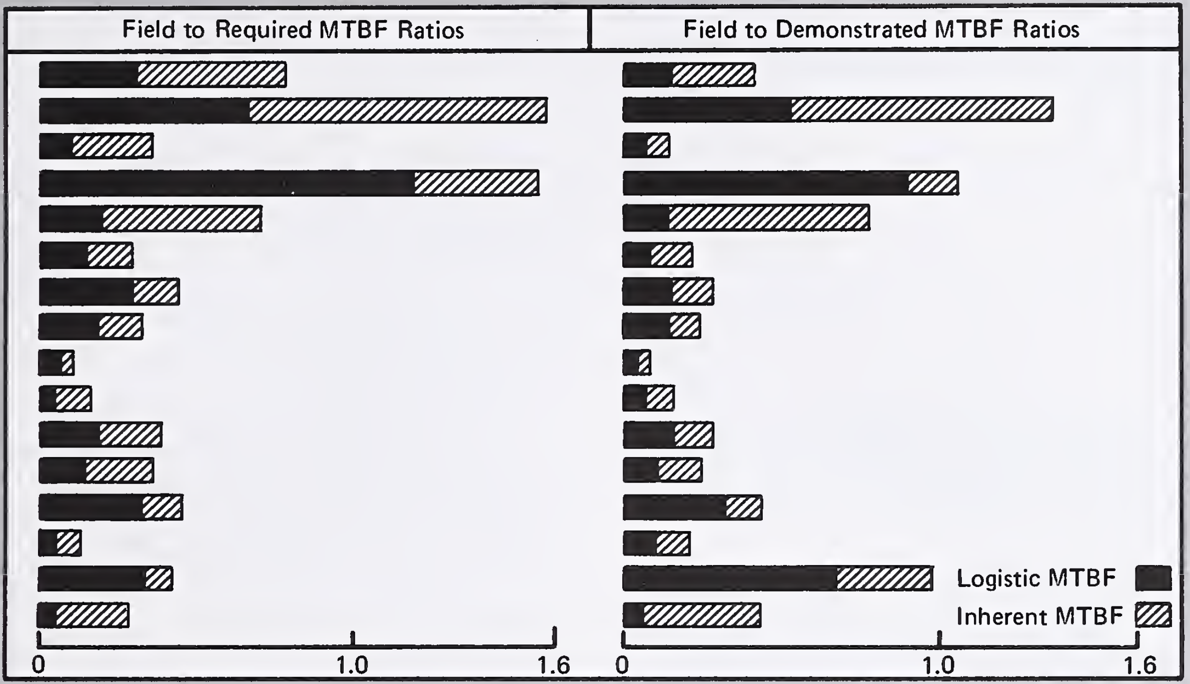
[7] *George Kern and T. Drnas, "Operational Influence on Reliability," RADC–TR–76–366, ADA A035016, Rome Air Development Center, Griffiss Air Force Base, NY, December 1976.*

[8] *A separately conducted study by Grumman Aerospace Corporation investigated the area of environmental differences between required, predicted, demonstrated, and field operational reliability of airborne avionics equipment. The results of the Grumman study are based on avionics equipments in current operational use on four different types of naval aircraft. Except for the obvious differences in carrier-based operations, it is believed that all other environments are relatively similar.*

[9] *G. Hirschberger et al., "Evaluation of Environmental Profiles for Reliability Demonstration," RADC–TR–75–242, Rome Air Development Center, Griffiss Air Force Base, NY, September 1975.*

[10] *Air Force Logistics Command Manual 66–15, "Product Performance," Wright-Patterson Air Force Base, OH, February 1970.*

Figure 1. Effect of Reassessment on MTBF Ratios



reported using the standard AFLC criteria, and the adjustment to the MTBF ratios obtained after reassessment using a consistent criteria for time and failure definition.

The shaded area (logistic MTBF ratio) represents the AFLC-reported level of achieved field MTBF, whereas the white area represents the adjustment to the achieved MTBF value after reassessment of the data using a consistent criteria to derive the inherent MTBF values. On the average, when the data were reassessed, the composite effect of the adjustments increased the reported MTBF values by a factor varying from 1.3 to 6.4 depending upon the equipment, or on the average by a factor of 2.4. The wide range of these definitional adjustments suggests that careful attention to the criteria used for reliability assessments is imperative, if meaningful results are to be obtained. These adjustments, referred to as definitional adjustments, were the largest single factor contributing to the reported differences between the predicted, demonstrated, required, and field operational reliability values.

Operational Influences

The operational influences on avionics equipment reliability can be divided into two categories. The first comprises maintenance handling factors related to the frequency of maintenance actions, the frequency of removal of the equipment from the weapon system during maintenance, the shop repair rate, and so forth. The second category, use factors, consists of such elements as mission duration, weapon system utilization rate, and operating to nonoperating time relationships. While the factors identified may not surprise those experienced in avionics reliability, it is significant to note that this is the first time that these relationships have been comprehensively studied, identified, and quantified.

Implementation of the regression analysis procedures to examine the effects of 18 field-related factors in all combinations produced a number of significant equations depicting the influence of the operational factors. The equations were ordered with respect to the demonstrated, predicted, and required MTBF. These relationships were developed subsequent to the removal of the definitional factors. In each group the significant measurable factors were segregated into two categories: maintenance handling and equipment use.

Maintenance Handling Influence

As might be expected, the more a given

avionics equipment is subjected to maintenance handling, the lower will be the relative level of MTBF achieved. The analysis results showed that the removal rate and percentage of shop repairs are significant measures of maintenance handling influence. These factors have a strong negative association with the expected field MTBF. Figure 2 illustrates the relationship between the ratio of expected field MTBF to the demonstrated MTBF and the level of maintenance handling to which it is subjected. For an item which had a demonstrated MTBF of 400 hours, the range of expected field MTBF achieved would be between 0.33 and 0.67 times the demonstrated value. The curves represent realistic estimates within which current generation avionics equipments are expected to fall.

The effect of different maintenance handling levels on the ratios is appreciable. Although the tails of fitted curves must be viewed with some caution, it appears that the larger ratios can be associated with the more complex hardware (lesser demonstrated MTBFs) and that a higher level of maintenance handling tends to limit the ratio on the order of 0.30 in this case.

The significant use factors found to have an influence on field reliability were mission duration (MD), utilization rate (UR), and the operating to nonoperating time ratio (OPTR). Figure 3 shows the field MTBF that may be expected for a given value of demonstrated MTBF when different levels of equipment use are considered. Again, the low, medium, and high levels of use are assessed by the clear separation of the lines, with the high equipment use relationship standing apart from the other two.

Following the same pattern, Figure 4 shows the field MTBF that may be expected for a given, demonstrated MTBF when the combined influence of maintenance handling and equipment use are taken into account. Note that these curves represent the range within which the expected field MTBF performance will fall using typical values, not extremes, of maintenance handling and use factors.

Additional effects of the combined operational factors are assessed in Figure 5 on p. 22. In this case the typical factor values employed are those partitioned by aircraft type. It is apparent that the field MTBF achieved by avionics equipments installed on heavy bombers, transports, or tankers is about twice that achieved when the same equipments are installed on fighters, interceptors, or trainer aircraft. These curves indicate that for purposes of future procurements involving either life cycle cost or reliability improvement warranty contracts, some recognition of the type of aircraft the equipment is to be installed in should be included. Similarly, for reliability predictions, a modifier to the failure rates used for aircraft environments should be developed to reflect the differences observed.

Influence Assessed

The overall influence of the operational factors were assessed on the basis of the percent of variation in the dependent variable (field MTBF) that is explained by the independent variables (operational factors) after accounting for the normalizing MTBF. On this basis a reasonable estimate of the overall operational influence on the field MTBF relative to the demonstrated MTBF is 51 percent. Extending this line of reasoning, the remaining unexplained variation, 49 percent, would be a reasonable estimate of the influence of other factors such as the different environmental levels applied to equipment in the field. Typically, these environments would include vibration, shock, temperature, humidity, and so forth. The estimated total operational influence on the field MTBF relative to the predicted MTBF, calculated in the same manner, is 45 percent.

Figure 6 on p. 22 provides a composite illustration of the impact of the definitional and operational factors. In column 1, the ratio of the demonstrated MTBF to the field MTBF based on raw data is approximately 6 to 1, whereas after the removal of the effects of the definitional factors, the same ratio is 2.4 to 1. When the definitional factors have been removed, 51 percent of the variation in the field MTBF may be attributed to the operational factors and 49 percent to environmental and other factors. Similarly, column 2 shows the composite impact relative to the predicted MTBF.

Performance Assessments

This study has shown that despite the much-publicized horror stories about avionics equipment unreliability, the average level of the field operational MTBF achieved for Air Force avionics equipment when compared by the same failure definitions and time base is 51 percent of the contractually required MTBF, and 49 percent in relation to the laboratory-demonstrated MTBF. The values are based on a carefully selected matrix of equipments and aircraft types, and represent total inventory performance of these equipments and weapon systems in the continental United States for a one-year period.

In addition to the quantitative results obtained, several interesting observations of the degree to which avionics field reliability performance varies were also made. These included comparisons of the same equipments on the same aircraft, of the same equipments on the same aircraft and mission at different bases, of the same equipments on different aircraft, and comparisons by aircraft type.

The first of the comparative investigations dealt with the degree to which equipment MTBF might be influenced by differences in the maintenance environment at different bases. For this investigation, three items of avionics equipment were selected on a high performance supersonic jet aircraft operated in a very closely regulated and controlled training role at nine different bases. The results of this analysis are summarized in Figure 7 on p. 22.

The data analysis results are presented in terms of the equipment's achieved MTBF by base normalized by the average MTBF for all bases. This permits direct comparison of the MTBF performance at each base versus the fleet average MTBF for each of the three different equipments. The equipments selected were a UHF communications radio, a TACAN navigation set, and an inertial platform, so that data representing the MTBF performance of the three different avionics functions could be compared at the nine different training bases. In addition to the MTBF achieved at each base for the three different equipment items, the average of the three values of relative MTBF achieved for each base was calculated. The object of the base average value is to smooth out the effect of large variations on one item of equipment and to provide an assessment of the impact on field-achieved MTBF due to differences in the base-to-base maintenance environment.

While caution is recommended against drawing inferences relative to the causal factors for

Figure 2. Influence of Maintenance Handling on Field MTBF to Demonstrated MTBF Ratio

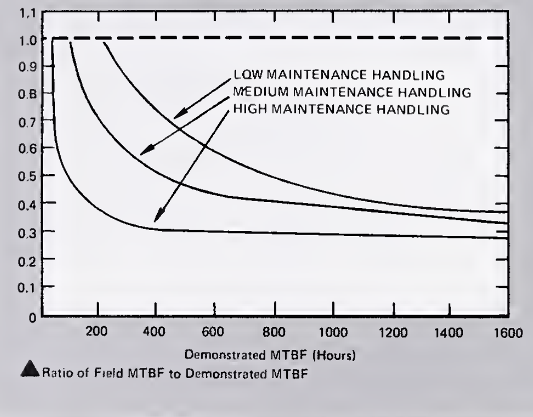


Figure 3. Influence of Equipment Use on Field MTBF to Demonstrated MTBF Ratio

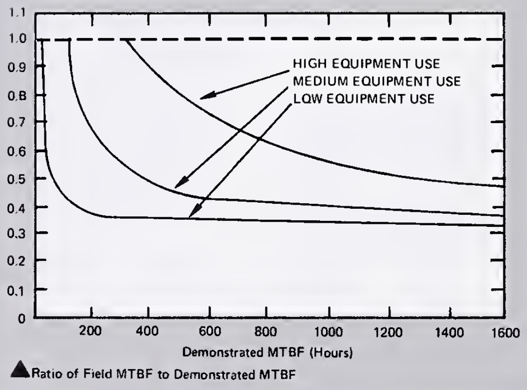


Figure 4. Influence of Combined Operational Factor on Field MTBF to Demonstrated MTBF Ratio

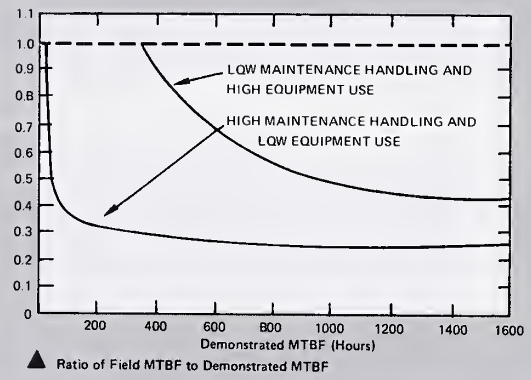


Figure 5. Influence of Combined Operational Factors on Field MTBF to Demonstrated MTBF Ratio -- Typical Levels by Aircraft Type

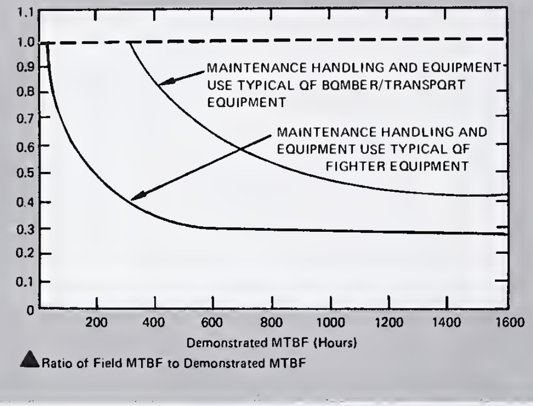


Figure 6. Composite Impact of Definitional Factors and Operational Factors

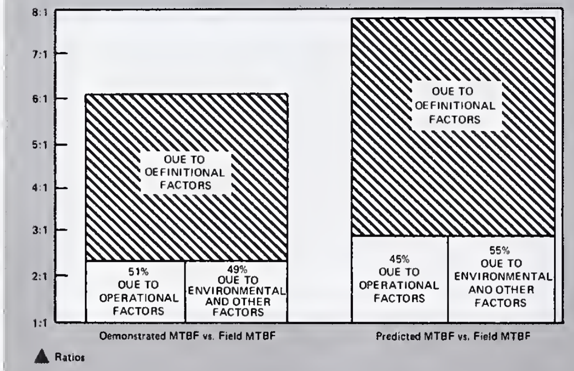


Figure 7. MTBF Performance Comparison at Nine Different Bases -- Identical Equipment and Aircraft

Base Number	Flight Hours	Base MTBF vs. Fleet Average MTBF			
		UHF	TACAN	Inertial	Base
1	19,963	1.01	0.88	1.09	0.99
2	19,295	0.96	0.62	0.94	0.84
3	21,953	1.11	1.24	1.03	1.13
4	18,747	0.72	0.57	1.06	0.78
5	16,100	1.04	2.85	0.99	1.63
6	20,999	1.13	1.98	1.15	1.42
7	21,124	1.09	1.00	0.99	1.03
8	14,279	0.93	1.02	1.17	1.04
9	26,865	1.19	1.14	0.80	1.04
Average Equipment MTBF		80.4	88.4	196.4	- -

the differences, it is evident from these data that fairly large differences in field MTBF can occur even though the same equipment is used on the same type of aircraft flying a virtually identical training syllabus at different bases. An excellent summary of how avionics maintenance is performed in the Air Force operating commands, and some of the variables involved, is given in a recently published report by AFSC.[11]

Typical Characteristics

To get a more detailed insight into the field MTBF performance of equipment used on several different aircraft, and the variations among the factors of interest that were identified through the preceding analyses, tabulations were made of the more significant performance indices of two different equipment types, each operational on two or more different aircraft. These equipments were a UHF communication radio and a TACAN navigation set. The data were arranged in three groups, namely the equipment MTBF values, the maintenance handling factors, and the use factors (Figures 8 and 9).

An examination of the MTBF values for the UHF radio discloses that this equipment had an MTBF requirement of 450 hours, a predicted MTBF of 1095 hours, and a demonstrated MTBF of 552 hours. Proceeding to the reassessed field MTBF values, one can see the wide range of variation of operational MTBF for what would appear to be the same equipment, performing the same function, on six different types of aircraft. Note the extreme values: MTBF equals 107 hours on weapon system H, a supersonic interceptor; and 917 hours on weapon system C, a cargo and transport aircraft.

Another significant difference not apparent in the data which should be considered is that on weapon systems A and C, the UHF communications installation is dual, in that each aircraft has two complete UHF communication sets. This should not be interpreted to mean that only one radio is operational at any given time, since it is normal practice to use both sets, each tuned to a different frequency. The effect

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[11] *P. Owens et al., "Avionics Maintenance Study," AFAL–TR–77–90, Air Force Avionics Laboratory, Wright-Patterson Air Force Base, OH, June 1977.*

Figure 8. Avionics Performance Indices - UHF Communication Radio

MTBF (Hours)				Maintenance and Handling Factors								Use Factor			
Req'd	Pred.	Demo.	Field	MTBMA	MI	% Fail	% Shop	% REM	% ADJ	% ND	% 800	MD	UR	OPTR	W/S
450	1095	552	269	109	.27	59	53	71	9	4	11	3.35	20.1	4.10	A
			123	63	.54	62	49	51	4	24	0	1.24	17.6	4.27	B
			917	281	.05	73	45	51	21	4	0	4.45	53.8	9.79	C
			107	61	.20	69	54	78	5	8	11	1.93	23.1	4.54	H
			142	106	.21	83	79	91	4	2	7	2.78	22.6	4.33	K
			134	79	.25	82	74	83	11	3	4	2.97	16.2	3.02	N

of having dual UHF radio installations on weapon systems A and C is that the pilots tend to be less critical of the radio equipment when a discrepancy occurs, because the crew can switch to the other radio and complete the communications, and consequently they are less likely to report the discrepancy on the postflight debriefing form than if it were a single installation on which they were solely dependent.

The maintenance-handling factors likewise reflect significant differences in some cases and reasonably similar performance in others. These show both the range and magnitude of the factors of interest and reflect total fleet values for a one-year period, thereby eliminating much of the variation normally seen when dealing with more limited data samples.

The first two factors—frequency in terms of mean time between maintenance actions (MTBMA) and maintenance man-hours expended per equipment flight hour (MI)—are indicative of the maintenance resources expended. The remaining maintenance-handling factors listed are expressed as percentages of the indicated "How Malfunctioned" or "Action Taken" codes relative to the total number of equipment maintenance actions associated with the equipment item. The values give a good indication of the range of variation and absolute values that are typical for this equipment on the six different aircraft systems.

The last group of data in Figure 8 gives a good indication of the magnitude and range of the three primary use factors of interest: mission duration, utilization rate, and operating to nonoperating time ratios for each of the six weapon system applications.

In summary, the data indicate that there is a considerable range of variation in field MTBF among the six different aircraft types, as well as variations in the associated maintenance handling and use factors.

The field performance indices for the TACAN navigation set installed on weapon systems A and D are shown in Figure 9. These are both supersonic jet aircraft; weapon system A is a medium bomber, while D is a high-performance training aircraft.

The data presentation format is the same as that described previously. Examining the MTBF values, it is seen that this equipment had an MTBF requirement of 1000 hours, a predicted MTBF of 2900 hours, and a demonstrated MTBF of 669 hours. The reassessed field MTBF shows a value of 129 hours on weapon system A and 106 hours on weapon system D, neither of which is significantly different.

Figure 9. Avionics Performance Indices - TACAN Navigation Set

MTBF (Hours)				Maintenance and Handling Factors								Use Factor			
Req'd	Pred.	Demo.	Field	MTBMA	MI	% Fail	% Shop	% REM	% ADJ	% ND	% 800	MD	UR	OPTR	W/S
1000	2900	669	129	50	.28	45	16	81	5	3	14	3.35	20.1	4.37	A
			106	48	.07	57	28	87	9	1	11	1.20	35.2	6.16	D

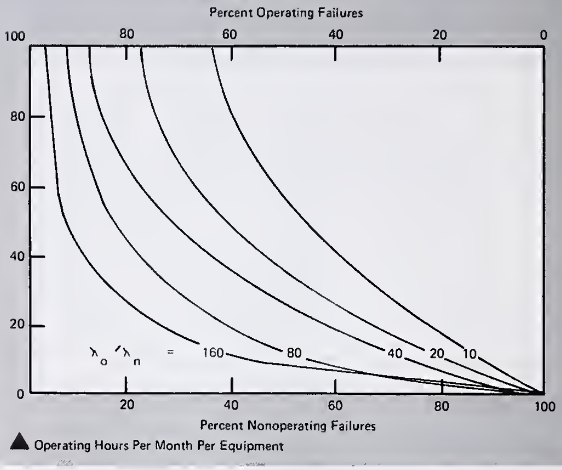
The remaining data presented in Figure 9 illustrate that contrary to the slightly lower indicated value of field MTBF for the TACAN on system D, the maintenance index (maintenance man-hours expended per equipment flight hour) is considerably lower than that reported for system A. The remaining maintenance-handling factors are comparable for both installations.

A review of the use factors indicates that there is almost a 3 to 1 difference in mission durations between the two applications, and almost a 2 to 1 difference in the utilization rates. However, the combination of a high mission duration and low utilization rates or vice-versa tends to yield no significant difference in the composite operational influences for either application.

The relative contribution of operating and nonoperating equipment failures was analytically assessed to calculate the expected number of failures based on given values of operating to nonoperating failure-rate ratios and given levels of equipment utilization rates. Since data on actual failure-rate ratios were not available, ratios of 10, 20, 40, 80, and 160 to 1 were assumed for this evaluation. The range of equipment-utilization rates used for the analysis was from 15 to 100 operating hours per month per equipment. These ranges encompass the range of values characteristic of the equipments included in the study. This resulted in the development of the nomograph in Figure 10, from which one can estimate the expected distribution of operating and nonoperating failures for a given item of equipment.

Maintenance action data for a one-year period on one equipment type were then analyzed and classified to derive a count of the number of failures that occurred during operating and nonoperating times. To classify the failures as either operating or nonoperating failures, the following rationale was applied to the "When Discovered" codes pertaining to each failure occurrence: If the code used was indicative of either preflight inspection, special inspection, quality control check, depot-level maintenance, or withdrawal from stock, the failure was considered to have occurred during the nonoperating time. All other failures were considered as having occurred during the equipment operating time.

Figure 10. Equipment Operating and Nonoperating Failure Contribution



The results of the failure data reclassification described indicate that 40 percent of the failures were associated with the nonoperating period and the remaining 60 percent occurred during the operating period. The values of utilization rates and operating-hour to flight-hour ratios for the equipment item investigated were 38.9 hours and 1.23 hours per month, respectively. From these values, 47.8 is calculated as the equipment's utilization rate. Entering the data on the nomograph, it can be inferred that the ratio of operating to nonoperating field failure rates for this equipment is approximately 20 to 1.

In the absence of more detailed data, this approach can provide a useful estimate of the current operational experience on a typical equipment item. The point made by this analysis is that a significant percentage of failures can and does occur during nonoperating time, yet the denominator of the equation

$$\text{MTBF} = \frac{\text{Operating Time}}{\text{Failures}}$$

normally includes all failures observed without regard to the fact that some of the failures occurred during nonoperating time. This is another source of the disparity between demonstrated MTBF and field MTBF, since demonstrated MTBFs use only operating failures and operating time for assessment purposes.

Conclusions and Recommendations

This study of 16 different avionics equipments now operational on 10 different Air Force aircraft types has identified a number of significant factors which contribute to the differences between field-observed reliability and demonstrated, predicted, or required MTBF values.

While many contributing factors were revealed, the primary causes were found to be the data base used for assessment, and, to a lesser extent, the operational influences of maintenance handling and use. However, generalizations do not always fit particular cases. For this reason, the prediction models developed for estimating field operational MTBF were designed to give upper and lower bounds for the estimated value.

The definitional differences observed are attributed to the differences in the failure criteria and time base used by the logistic support community (AFLC) which collects and analyzes the data, and the engineering community (Air Force Systems Command and industry) which establishes requirements, performs predictions, and conducts reliability demonstration tests. The definitional differences are composed of two parts, one related to the time base used for MTBF assessment, the other to the failure criteria used for assessment purposes.

The following conclusions and recommendations are offered:

- The AFLC-reported MTBFs based on aircraft flight hours were increased by factors ranging from 1.2 to 2.7 when the equipment operating hours were used to compute the field MTBF. The average increase for all 16 equipments was twice the AFLC-reported field MTBF. In terms of operational MTBF achievement relative to the required MTBF, the AFLC-reported MTBF increased from 0.21 to 0.42. When the failure classifications were reassessed and adjusted, the composite effect of the failure definitional adjustments increased the field-to-required MTBF ratio from 0.42 to 0.51.
- The primary operational influences are those related to maintenance handling and equipment use. These operational influences collectively account for about half of the remaining differences after definitional factors between the observed (reassessed) field MTBF and the demonstrated MTBF are removed, and about 45 percent of the remaining differences when related to the predicted MTBF.
- The review of the failure relevancy criteria revealed that two related, but differing, reliability characteristics are responsible for the differences in failure classification criteria. These are the inherent reliability (engineering oriented) and the operational reliability (logistics support and operations oriented). Until these differences are clearly recognized and understood, confusion as to the meaning of MTBF will continue to exist.
- A limited analysis of maintenance action data indicates that approximately 60 percent of maintenance actions are expended on the prime avionics equipment items and the remaining 40 percent on system interfaces and associated hardware. This suggests that the latter two areas may be prime targets for cost reduction and reliability improvement.
- The differences in assessed field operational MTBFs suggest that it may not be valid to use a single environmental factor for aircraft without regard to the type of aircraft when making reliability predictions. Possibly the environmental factors given in Military Handbook 217B should be adjusted by an appropriate modifier to reflect differences in aircraft type.
- Nonoperating failures can make a significant contribution to the assessed field MTBF for avionics equipment. It is estimated that between 20 and 60 percent of the failures recorded during operational deployment of avionics equipments are actually nonoperating failures. This suggests the need to establish several separate measures of MTBF, each directed at a specific objective. One would be used to determine inherent reliability (based on operating hours), one to determine field operational reliability (based on flight hours), and another to determine logistic support reliability (based on calendar time; that is, months or years). Such an approach would contribute significantly to a better understanding of the meaning of MTBFs and result in more accurate data. DMJ

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Mr. Kern has some 28 years of industry experience, with specific expertise in the design, development, and test and evaluation of electronics equipments for military weapon systems.

Mr. Kern has a B.S. degree from Newark College of Engineering, Newark, NJ, and has done graduate work at Stevens Institute of Technology and at UCLA.

Taking a Look at the Request for Proposal

This very basic instrument in the procurement process needs careful consideration by DoD and industry alike.

When the government purchases large, complex weapon systems, the request for proposal is one of the key instruments of communication between the procurement officer and the seller of the product or services. The potential seller must understand clearly the contents of the request for proposal in order to respond properly to the procurement requirements. The request for proposal, however, has been criticized variously for being too long, for requiring too much nonessential data from the offeror, and in general for being a poor communications instrument.

In 1975 a study was conducted under the auspices of the Business Research Management Center, Wright-Patterson Air Force Base, to determine how contract administrators viewed the request for proposal as the first communications instrument in the acquisition process. The study was designed to solicit the opinions of major defense contractors. It was preceded by a review of the literature regarding the request for proposal to determine what actions had previously been taken.

In the literature search, two prior studies were located. Both studies were conducted in 1969: one was completed by an Air Force team of procurement specialists; the other, by members of the Aerospace Industries Association of America.

The studies followed similar formats. Each included a critical evaluation of several requests for proposals and a review of the regulations and directives that applied to the procurement process.

by Cecil V. Hynes
Associate Professor of Marketing
University of Maryland
College Park, MD

Opinions expressed herein are those of the author and not necessarily those of the Department of Defense.

The Air Force study reviewed in detail three requests for proposals which were typical of recently completed formal source selection activities. The RFPs selected were: the second source procurement for the Minuteman III Guidance and Control Set contracted by the Space and Missile Systems Organization, the Aeronautical Systems Division AGM-65A Maverick Missile procurement, and the Electronic Systems Division TPN-19 Landing Control central procurement.[1]

The Aerospace Industries Association study used proposals for the short-range attack missile, the C-5A cargo airplane, and the airborne warning and control system as case studies to demonstrate industry's experience in working with requests for proposals.[2]

Both studies made similar, fundamental recommendations. For example, each recommended page limitations for the requests for proposals and for the contractors' proposals. Both studies also recommended a careful screening of the requirements placed on contractors for the provision of data, certificates, and management reports.[3]

The only published articles located during the literature search which dealt directly with the request for proposal appeared in the January 1973 issue of the *Defense Management Journal*.[4] These articles generally characterized the requests for proposals as excessively long documents, written in such a manner as to encourage contractors and responding companies to place a large volume of nonessential information in their proposals. Many of the points raised in the *Defense Management Journal* articles were the same as those addressed in the Air Force and Aerospace Industries Association studies.

In May 1973, the Aeronautical Systems Division of the Air Force Systems Command published ASD Pamphlet 800-6 to provide guidance for improving and simplifying the request for proposal.[5] This publication suggested reorganizing the request for proposal in a format that

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[1] *Assistant Secretary of the Air Force (Procurement), "Air Force Request for Proposal, Study Team Final Report," Washington, DC, 1969.*

[2] *Aerospace Industries Association of America, "An AIA Study of United States Air Force Requests for Proposals, Critiques, and Recommendations," Washington, DC, December 1969.*

[3] *The Air Force study suggested assembling experts to assist the system program office in identifying unnecessary requirements in the RFP. The AIA study suggested a formal, top-level RFP review, preferably at the Assistant Secretary level, to take place prior to RFP issuance to ensure elimination of requirements which trigger excessive effort and documentation.*

[4] *Brigadier General A. L. Esposito, USAF, "An Analysis of Frustrations: The RFP-Proposal Cycle,"* Defense Management Journal, *January 1973, p. 8; Lieutenant General James T. Stewart, USAF, "Source Selection Process Faces Winds of Change,"* Defense Management Journal, *January 1973, p. 13; and Steele Morris, " 'Communications Effectiveness' Needed in RFP-Proposal-Contract Award Cycle,"* Defense Management Journal, *January 1973, p. 17.*

[5] *Headquarters Air Force Systems Command, Aeronautical Systems Division, ASDP 800–6, "Request For Proposal Preparation Guide," Andrews Air Force Base, MD, May 29, 1973.*

Figure 1. AFSC's Proposed Organization of the RFP in 1975

Volume I:	Proposal Preparation Instructions
Volume II:	Model Contract -- Supplies and Services -- Contract Terms/Conditions -- Contract Administration Data -- DD Form 1423
Volume III:	Attached Documents and References -- Statement of Work -- Specifications -- Engineering Drawings -- DD Form 254 -- Contract Work Breakdown Structure
Volume IV:	Classified Parts of RFP, If Any

would facilitate more effective communication with the potential seller. The recommended format, which permitted the reader to proceed through the request for proposal in a logical manner, separated the RFP into four parts:

- Volume 1: executive summary (proposal preparation instructions).
- Volume 2: model contract.
- Volume 3: reference documents.
- Volume 4: classified parts of the request for proposals.

The development of the above format appeared to be the first major effort by any service organization to put into action any of the recommendations pertaining to the request for proposal problem as suggested by the Air Force and Aerospace Industries studies.

Two years later, in May 1975, the Air Force Systems Command published Pamphlet 70-4, " Request for Proposal Preparation Guide," which superseded ASDP 800-6 but which retained much of the material contained in the earlier pamphlet. The information in Pamphlet 70-4 was oriented primarily toward documents controlled under Air Force Regulations 70-15 and 800-2; however, the concepts and procedures could be tailored for limited funding and less complex procurements.

Pamphlet 70-4 recommended that the request for proposal be transmitted to the offeror with a brief executive summary letter; this letter would provide top management, both in industry and government, with a concise review of the salient features of the procurement. Additionally, the pamphlet presented a detailed arrangement for organizing the request for proposal into four separate volumes (Figure 1).

The 1975 survey research study was undertaken to collect data on how industry contract administrators perceived the request for proposal.[6] A questionnaire instrument was developed for securing the data. Because of cost considerations, no personal interviews were conducted.

The statements used in collecting the data were based on information and ideas that were gained through reading requests for proposals, the Air Force and Aerospace Industries Association studies, and the *Defense Management Journal* articles dealing with RFP problems. They were designed to determine whether industry users perceived the requests for proposals in the same manner as those who had studied RFPs, had written about them, or were currently writing RFPs for procurements.

The instrument was mailed to 108 of the largest defense contractors. The names of the contractors were taken from a list published in the November 25, 1974, issue of *Aviation Week and Space Technology,* while the names of contract administrators and marketing vice presidents were found in the *Standard and Poor's Directory of Businesses.* The response rate was approximately 67 percent, which is considered good for a survey study of this type.[7]

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[6] *The study was suggested by the author as a part of a continuing effort by the Business Research Management Center, Wright-Patterson Air Force Base, Ohio, to encourage Air Force specialists and academicians to undertake research projects dealing with the Air Force procurement process. For additional information on this program see: Cecil V. Hynes, "Air Force Business Research Management Center Offers Research Opportunities Even For Those at Civilian Universities,"* Marketing News, *October 24, 1975, p. 3.*

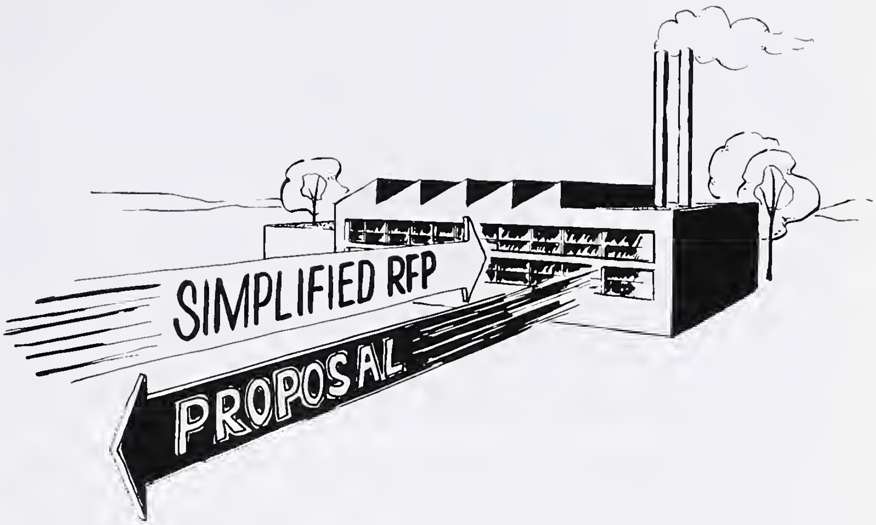
[7] *Paul E. Green and Donald S. Tull,* Research for Marketing Decisions *(Englewood Cliffs, NJ: Prentice-Hall, 1970), p. 158. For mail questionnaires, the model response rate is on the order of 20 to 40 percent.*

Because of the manner in which the sample was selected, the findings were limited and showed only the perceptions and opinions of the individual respondents. It would be difficult and probably erroneous to generalize from those findings. However, the respondents held responsible positions with large defense contractors and collectively represented a wealth of experience in dealing with requests for proposals from industry's view of the procurement process.

Another limitation inherent in this type of research was the necessity of making generalized, and sometimes simplified, statements on the instrument used to collect data without being able to tie the statements directly to a specific procurement action. The questions presented to the respondents were written in general terms that might appear in any request for proposal for either large complex weapon systems or smaller procurements. However, because only the largest contractors, who tended to be primary contractors, were selected, it was anticipated that the respondents would represent firms dealing with large, complex weapons procurements. A review of the findings and comments suggests that these were in fact the individuals reached by the study.

Findings

Figure 2 on p. 30, which depicts the industry questionnaire, reflects the percentage spread of responses to the questions. The summation of responses to each question is portrayed in Figure 3 on p. 31.



A review of the questionnaire indicates that a majority of the respondents agreed with most of the questions. However, many tended to be undecided about or to disagree with questions 2, 11, 15, 18, 22, 23, and 24.

The respondents were also asked to write their suggestions for improving the requests for proposals. Several submitted specific recommendations, of which the following were the most significant:

- Eliminate the practice of adding to the RFP requirements for data that are not essential to the main purpose of the RFP, but in general appear to be put into the RFP because some department requires information or needs only to be aware of an activity.
- Eliminate or minimize evaluation criteria that promote gamesmanship on the part of the offerors or gimmicks being offered rather than hard, cold, conservative, prudent, and sound information; for example, "this is what we can do," or "this is how we can do it."
- Provide adequate advance notice of impending RFP release.
- File early, with a central agency, the RFP pages containing standard contractors' representations, certifications, and acknowledgments. The RFP then would require only one block to insert a file number or similar identification of compliance.

The Respondents

The respondents were asked for information about their companies' total sales, the percentage of sales to the government, the title of their positions, the length of time they had spent in those positions, and the number of years they had worked with requests for proposals. Eleven chose not to supply this information.

Those who complied with the request reported sales varying

Figure 2. Industry Request for Proposal Questionnaire

Code: Strongly Agree (SA); Agree (A); Undecided (UND); Disagree (DA); Strongly Disagree (SD)

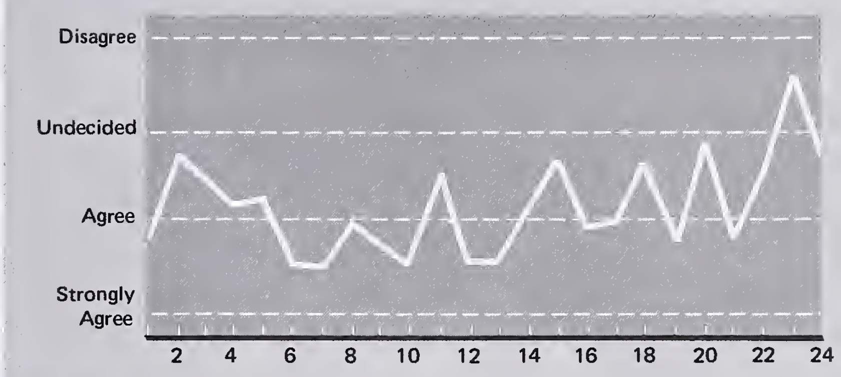
Question	Responses (number)	SA	A	UND (percent)	DA	SD
The procurement office should provide an "Executive Summary" of the Request for Proposal which would be a concise summary of the salient features of the procurement.	71	45	41	3	8	3
The number of pages in a Request for Proposal should be limited.	73	12	42	8	36	2
The number of pages in the contractor's response for technical proposals should be limited.	72	19	49	1	28	3
The number of pages in the contractor's response for management proposals should be limited.	72	26	51	0	23	0
The procurement officer responsible for source selection on complex weapon system procurements should visit each offeror's facilities before source selection is made.	70	31	41	10	13	5
The data requested by the Request for Proposals from offerors should only be requested if it helps the source selection authority to make a better decision.	72	47	50	0	3	0
The material in a Request for Proposal should be organized and arranged so the bidder gets the story in a logical step-by-step fashion.	72	51	49	0	0	0
The Request for Proposal should be very explicit in explaining to the bidder all concepts, requirements, and risks in the proposed procurement.	69	41	38	8	13	0
The objectives of the technical and management approaches should be clearly defined in the Request for Proposal.	73	48	45	4	3	0
Unrealistic requirements should not be included in a Request for Proposal.	72	65	28	4	3	0
A standard outline should be developed for writing all Requests for Proposals.	73	16	37	15	26	6
When bidders are required to make trade-off studies to select the best approaches, the relative importance of such factors as weight, performance, reliability, development time, risk, maintenance, and costs should be defined in the Request for Proposal.	73	48	44	1	6	1
The Request for Proposal should give firm criteria for proposal evaluation, as well as the actual or appropriate weighting factor for each of the criteria or group of criteria.	73	48	47	3	1	1
The Request for Proposal should specify the degree to which each referenced document (ASPR, DoD regulations, Air Force regulations, etc.) is applicable in the contract and the degree to which it is to be discussed in the proposal.	70	27	47	12	14	0
The Request for Proposal should provide a definitive proposal outline that should be followed by all bidders.	72	21	28	13	37	1
Before sending the Request for Proposal to bidders it should be read by objective nonparticipating reviewers who would take the bidder's viewpoint and recommend changes that would improve communication.	73	27	58	7	4	4
The source selection authority should rely primarily upon existing evaluations of contractor's procedural systems, and upon direct inspections at contractors' facilities in lieu of requesting voluminous plans.	73	29	53	9	7	2
The Request for Proposal should allow offerors more time for response.	69	17	28	28	28	0
The time allowed for response to the Request for Proposal should be related to the complexity of the procurement.	73	37	56	1	4	1
A minimum response period for any weapon system Request for Proposal should be:	68	(30 days) 12	(60 days) 26	(90 days) 38	(120 days) 16	(more) 7
The sections of the ASPR dealing with Request for Proposal should be reviewed by a committee of government and industry procurement specialists and rewritten to reflect the present procurement environment and lessons learned in the past few years.	72	38	40	15	7	0
Generally the ASPR is too constrictive as it tries to insure impartiality with the result of sacrificing efficiency in the procurement process.	49	31	37	32	0	0
Requests for Proposals for non-complex weapon systems are easily understood and therefore no changes are recommended.	69	2	15	26	44	14
A well-written, brief Request for Proposal is the primary key to improving the government's procurement process.	71	14	39	20	23	4

from a low of $200 million to a high of $31.5 billion. The median sales figures for the firms were $250 million; the median sales to the government were $108.9 million, or 43.5 percent of the median total sales.

The average length of time the respondents had spent in their positions was 6 years. Only three had held the same posts for over 15 years.

The respondents as a group had spent a total of 1,209 years working with requests for proposals, an average of 19 years per person. Clearly they had had ample experience working with RFPs, and that experience had qualified them for responsible positions. Twenty-three respondents were vice presidents (executive vice presidents, or vice presidents of marketing, finance, or contract administration), twenty were directors of contracts or contract administration, and eighteen were marketing and sales managers. All of this suggests that their opinions carried some weight.

Figure 3. Summation of Responses to Each Question in the Request for Proposal Study



Summary and Conclusions

The foregoing review of industry contract administrators' perceptions relating to the development and use of the request for proposal points up the fact that the majority of the respondents agreed with the statements presented to them, which suggests that they agreed with many of the recommendations made in the 1969 Air Force and Aerospace Industries Association studies and the suggestions for improving the request for proposal that were presented in the January 1973 issue of the *Defense Management Journal.*

The findings were admittedly limited, inasmuch as the sample selection was small and based on judgment, and presumably those with strong feelings regarding the requests for proposals were the ones who responded and offered additional comments. This may have biased some of the findings, yet it should be reiterated that the respondents, collectively, represented impressive professional experience in dealing with the request for proposals from industry's side of the procurement process.

Despite the study's obvious limitations, the findings should provide procurement policy makers with new insights and information regarding RFPs. Simply from a communications standpoint, it is helpful to understand how the recipient of the message perceives the message and the instrument by which the message is conveyed. These perceptions by industry of the request for proposal might provide the motivation for a new look at this document with a view to making it a better means of communication.[8]

Finally, the study might serve as the basis for developing future research pertaining to the request for proposal and other elements which are essential to the government procurement process.

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Prior to his academic career, Dr. Hynes worked for 14 years in private industry where he held various managerial positions in truck leasing, industrial marketing, and motor carrier transportation.

Dr. Hynes holds B.A., M.A., and Ph.D. degrees from Michigan State University. He has published articles in business administration journals and has authored books on marketing to governments and international trade and motor carrier reciprocity.

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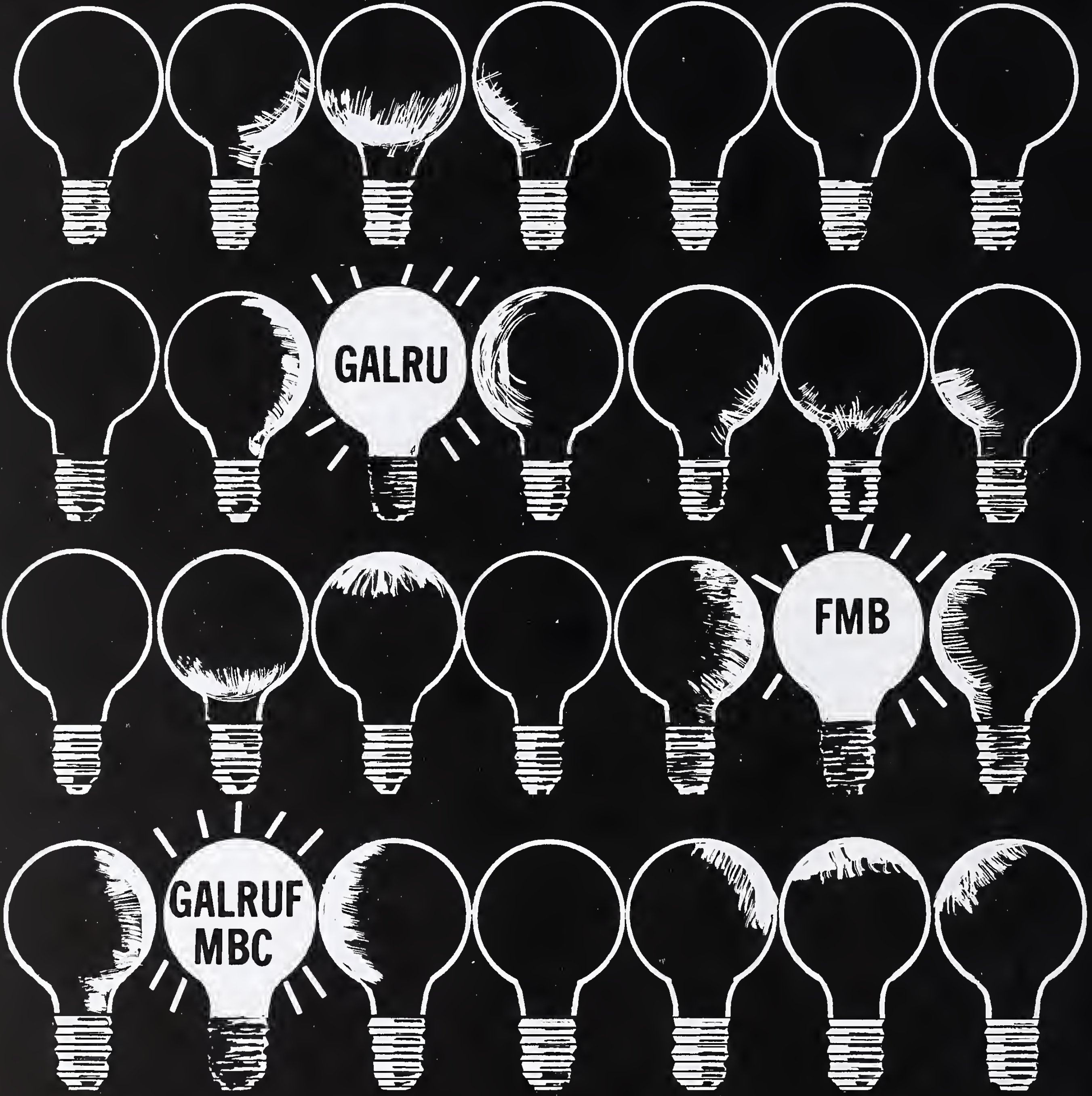
[8] *It should be noted that recent Department of Defense initiatives address certain points made previously by industrialists. Department of Defense Directive 4105.62, "Selection of Contractual Sources for Major Defense Systems," January 6, 1976, addresses RFP feedback, minimum expense, and model contracts. DoDD 5000.2, "Major System Acquisition Process," January 8, 1977, says that information requested should be limited to that essential to the contract, and that the contractor's existing data should be utilized whenever possible.*

On the Effects of Modularity on Operating and Support Costs



Our pseudonymous author, rumored to be an analyst somewhere in DoD, finds that a little inspiration can lead to some rather farfetched notions.

It was early evening in the dimly lit cocktail lounge, and I was relaxing after a long day by nursing a parched martini, the pair of olives nestled in its depths blankly staring back at me. The hectic nature of the day had nearly immobilized my body, but had inspired my brain to frantic activity.

I had just attended the first day's sessions of an operating and support costs symposium. The presentations had been highly thought-provoking. Letting my mind wander back to the previous day, when Dr. Marco Fiorello and I had discussed various issues involved in modularity, I coalesced that conversation with the more stimulating points of the symposium and conceived three sharply different approaches to aircraft avionics modularization.

GALRU

In my first case, all of the avionics are in one Giant Avionics Line Replaceable Unit (as is the bureaucratic wont, we'll call it a GALRU). Naturally, a few physical difficulties might be encountered; for instance, a crane would probably be necessary standard ground equipment to install and remove the GALRU (in the interests of cost-effectiveness, the crane could do double duty on other jobs as well). There might also be a center of gravity problem, but we'll presume that it could be overcome by our aircraft design people, who typically seem to be in search of a challenge.

by Rustle Em Jenay
DoD Analyst?

With but a single LRU to malfunction, flight-line diagnosticians wouldn't be bothered with pulling the wrong unit. This would presumably reduce false removals to a very low rate. And integrated avionics would now come into its own.

Certain life cycle cost enthusiasts, hung up on introducing new LRUs into the inventory, would predictably anathematize the GALRU. But limiting the LRUs to one per new aircraft would substantially reduce such problems as LRU management, assignment of Federal Stock Numbers, and so on. The number of technical orders would also be trimmed to one, although it would be 27 feet thick (wheels and a motor could be attached to its cover to make it sufficiently mobile). Costly hot mock-ups in the field would be avoided since the GALRU would serve as its own hot mock-up. Finally, those taxing decisions on which LRUs to modify would be eliminated, there being only one LRU, and a significant amount of study money and modification board time would be saved.

Of course, there might be a minor drawback or two. Since any failure would require removal of all the avionics from the aircraft, there would inevitably be quite a few of these giant LRUs being shuffled between the flight line and the intermediate-level shop, which might prove to be a trifle expensive in terms of spares. However, proper application of design to cost could keep this under control.

While 100 percent field-level repair of the LRU is theoretically possible using Shop Replaceable Units from the depot, in actuality, with complex avionics some of the LRUs are always NRTS'd back to the depot for repair for one reason or another. Again, stocking this pipeline could be expensive.

Those people promoting avionics standardization across various types of aircraft would no doubt tend to frown on the GALRU, but Reliability Improvement Warranty proponents would be delighted in that one RIW would cover all. Some analysis would be needed to verify the GALRU concept, but the fact that there is only one LRU should simplify this process enough to compensate for the less-consequential problem of having 5,000 SRUs.

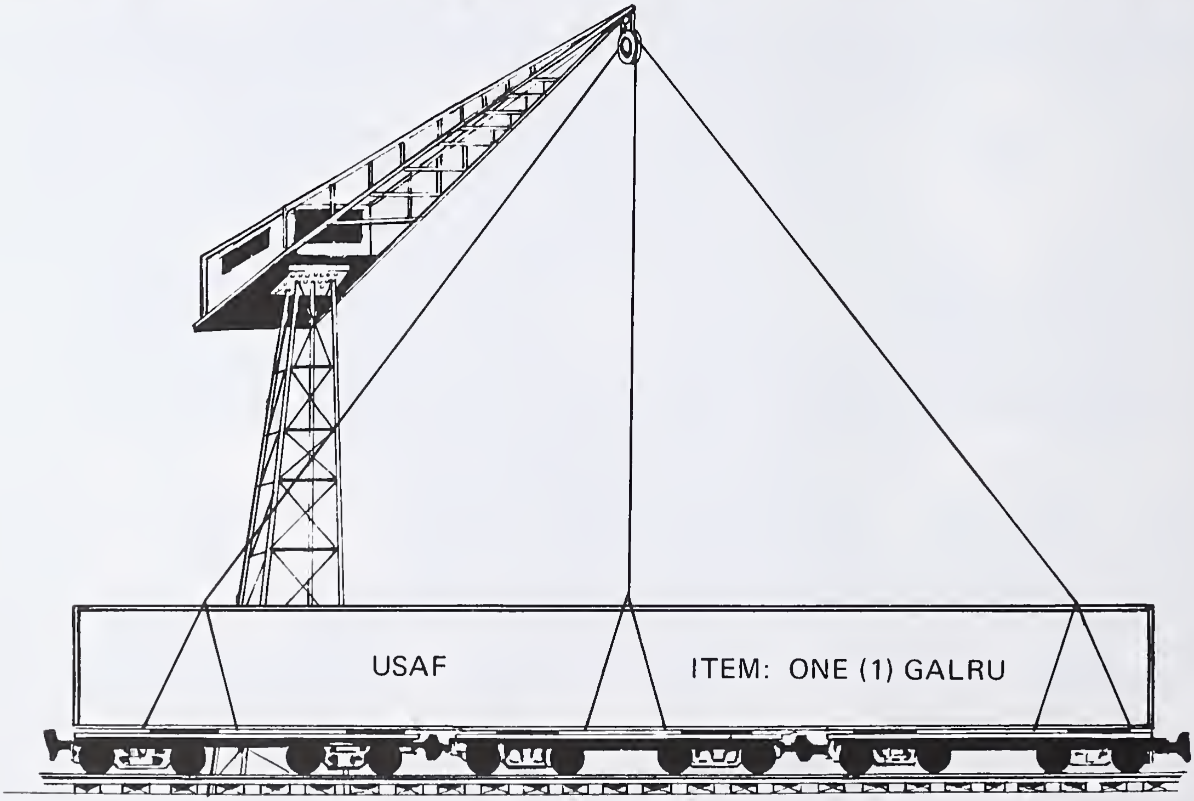
FMB

As you have probably anticipated, in our second case every resistor, transistor, integrated circuit, etc., is an LRU. The biggest problem here is that there would have to be as many connectors as there are discrete components, not to mention the mass of interconnecting wires. One might initially conclude that 5,000 pounds of connectors is an insurmountable problem, especially since there must be easy flightline access to each LRU, i.e., component. Obviously, surface area would have to be rather extensive.

No problem for the imaginative government manager: we simply turn these difficulties into an asset by replacing the aircraft skin and structure with one huge mother board. The monocoque construction would be the absolute last word in avionics-structure integration. Plugged into the stressed-skin mother board would be the 127,532 LRUs. Should there prove to be insufficient surface on the inside of the aircraft, the LRUs could also cover its outside. Significantly, this would save money by eliminating any requirement for speed brakes or vortex generators.

The standardization folks would be extremely pleased with the FMB, since standardization would be completely captured at the LRU level without infringing on design freedom.

I will admit that it may take a little longer to find the right LRU to replace on the flight line since there are 127,532 from which to choose, but this would certainly be more than offset by



the complete elimination of intermediate- and depot-level maintenance. Just think how much could be saved by closing depots and excluding all intermediate and depot automated ground equipment! And SRUs would be eliminated forever!

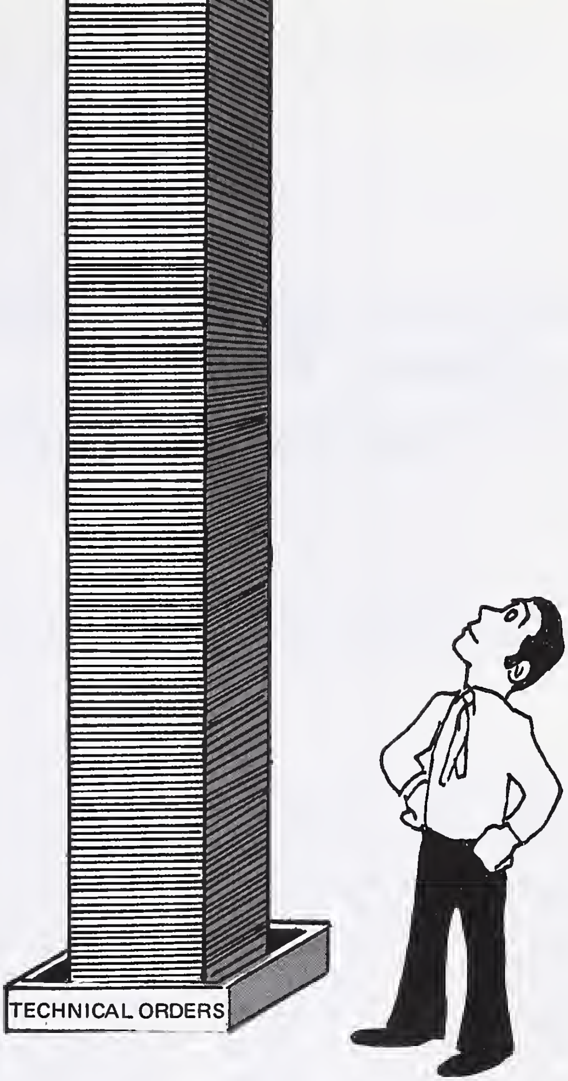
Another enormous benefit would be the elimination of all the expense and bother of optimum repair-level analysis, as there would be only one level of repair. We would also have achieved the impossible dream of all true R&Ders: 100 percent throw-away LRUs (thank goodness you can't fix a resistor). While there would probably be corrosion problems when dealing with 127,532 connectors, space limitations in this article preclude further discussion of this topic at this time.

Since there isn't a computer simulation program that can handle 127,532 LRUs, analysis to verify the flying mother board concept would have to be done by hand.

GALRUFMBC

For those pessimists not sold on either of the above alternatives, there is a middle ground—the GALRUFMBC (the C standing for compromise). The trick is to take the best features of each extreme while avoiding the bad. This would necessarily involve some compromises and trade-offs requiring study, analysis, and even hard thinking—not to mention voluminous reports, lengthy meetings, and state-of-the-art seminars. But who is better suited to such a task than a professional bureaucrat? The crane required for the GALRU might be a difficult notion to sell, so some upper limit on LRU weight would be essential. With women now participating more fully in maintenance tasks and some of us old men having weak backs, this limit would be set at 30 pounds. The potential center of gravity problem on the GALRU thus disappears as the LRUs can be distributed around the aircraft a bit (but 500 pounds should be added to account for interconnecting cables).

Because there would now be more than one LRU to pull, we would need to be concerned with pulling the right one most of the time. As the number of LRUs increased, high diagnostic error rates would become less tolerable. Integration and software problems between LRUs would need careful attention. Hot mock-ups would probably have to be provided to the field so that those personnel wouldn't have to sneak one together under the cover of darkness.



By adroitly arranging LRUs by functional characteristics and failure rates, diagnostic errors could be reduced, and pipelines would not be filled with loads of nonfailed and expensive material. The flying mother board advantage of standardization could be partially retained if the functional arrangement of LRUs was so ingenious that it even considered multiple aircraft-type applications. Lost in the compromise, however, would be throw-away LRUs. Finally, we would have to retain optimum repair-level analysis, not to mention depots.

But then being an analyst by profession myself and having a distinct inclination to stay one, I generally prefer the compromise position, which coincidentally would require the use of my skills. DMJ

Relating Promised Performance To Military Worth: An Evaluating Mechanism

A multi-attribute utility evaluation procedure is successfully applied to the Navy's Electronic Warfare Suite.

Editor's Note: This article is an abridged version of a technical report describing the multi-attribute utility approach and its application to a major military system. See Michael L. Hays, Michael F. O'Connor, and Cameron R. Preston, "An Application of Multi-Attribute Utility Theory: Design-to-Cost Evaluation of the U. S. Navy's Electronic Warfare System," Technical Report DT/TR 75-3, Decisions and Designs, Inc., McLean, VA, October 1975.

Current Design to Cost acquisition policy implies the need for explicitly relating performance to military worth within a cost constraint as a means of evaluating contractors' design proposals for major military systems. A multi-attribute utility evaluating procedure addressing this requirement was one result of research sponsored by the Defense Advanced Research Projects Agency, monitored by the Office of Naval Research, Department of the Navy, and directed toward developing, applying, and transferring to users in the Department of Defense advanced management technologies for decision making. This article describes the application of this MAU evaluating procedure to the evaluation of contractors' proposals for the Navy's Electronic Warfare System, a group of sophisticated and complex, semiautomated, computerized suites for detecting and responding to different threats to different naval vessels in different situations. This article details the MAU model used to evaluate the Navy's Electronic Warfare System design proposals as an illustration of a new and successful approach to evaluating major military systems under current DTC acquisition policy.

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Opinions expressed herein are those of the authors and not necessarily those of the Department of Defense.

Background

Faced with tightening budgets and increasing costs in the acquisition of major military systems, DoD promulgated in 1971 a DTC acquisition policy linking designed performance and other benefits to cost ceilings. This policy is not another formal pronouncement reemphasizing the importance of performance on the one hand and economy on the other. Instead, Defense Department directives enunciating DTC policy integrate both concerns, with significant implications for the procurement cycle of design, production, and scheduling.[1] In doing so, DTC policy attaches great importance to design by making cost a design parameter and stressing the need for tradeoffs between design and system capability.

Reflecting the central tenets of DTC policy are the cost-per-unit ceiling and the general absence of performance requirements in requests for proposals. By stipulating a cost-per-unit ceiling, DTC RFPs make cost overruns and insufficient acquisitions less likely. Because of this ceiling, costly improvements in one area of system capability must be balanced against possible, economically mandated deterioration in another. Since performance requirements may require such improvements, properly stated DTC RFPs minimize or eliminate performance requirements and give contractors considerable latitude in designing systems for certain missions in certain scenarios. As a result, they challenge contractors to design systems maximizing the military worth, or benefit, of their total performance within a cost constraint. Since system designs reflect contractors' different corporate, industrial, and technological capabilities and interests, and their different interpretations of the missions of the system, contractors are likely to propose highly diverse systems, each promising to satisfy the military service's needs.

Evaluating Design Proposals

The cost-per-unit ceiling and the general absence of performance requirements make evaluating diverse design proposals more difficult than it has been in the past, since all contractors are likely to propose designs meeting the cost-per-unit ceiling. Paradoxically, for those designs proposing and then estimated to meet the cost-per-unit ceiling, cost itself is no longer a significant consideration in evaluating the proposals. Moreover, RFPs stating missions and scenarios rather than performance requirements alter the focus of the evaluation process from a direct consideration of system capabilities to an analysis of the military worth of the total performance of the system.

Accordingly, the military service confronts the crucially important and extremely complex problem of evaluating diverse design proposals without employing the customary criteria of cost or common performance requirements. The logic of evaluation and the nature of competitive bidding require that any program for evaluating the military worth of proposed systems must be carefully constructed to meet four criteria; namely, it must discriminate effectively among the alternative design proposals, and it must be reliable, intelligible, and equitable. Any program meeting these criteria has but one operational purpose: to relate measures of performance of the controllable parameters of a design proposal to the total military worth of the proposed system. Only after such an evaluation does the service need to estimate the contractors' abilities to meet the cost-per-unit ceiling.

The first two criteria, discrimination and reliability, are satisfied or not by the nature of the

Aspects of the Model

Structuring

The many considerations addressed in developing an MAU model are finally organized hierarchically; more general elements are successively decomposed until a structure is developed that aggregates measures of performance characteristics up through TSU of each design proposal or that justifies any higher-level figure of utility or effectiveness by reference to lower-level figures. For these reasons, correct structuring of the problem is the most important step in the process. Moreover, correct structuring helps to reduce possible errors in judgment and to ensure that variations in the design proposals are reflected in different figures of TSU.

Utility and Effectiveness

The words "utility" and "effectiveness" are used in this article in senses consistent with, though not necessarily so specific as, their usage in related disciplines. "Utility" is mainly applied to evaluation (in the narrow sense), "effectiveness" to prediction, and each has its important part in evaluation (in the broad sense). The distinction, admittedly slight (see Figure 1 for the area in which simulation runs may or may not be used), is that between determinations involving military tradeoffs and those involving technical system capabilities.

Scaling

Since an MAU model involves many different kinds of elements and many different units of measurement, it is important to have a common unit of measurement that makes all measures commensurable to facilitate aggregation up through the model. The convention is to scale either utility or effectiveness from zero to 100. Accordingly, various performance characteristics may be measured as percentages which become amenable to aggregation at higher levels in the MAU model.

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[1] *Department of Defense Directive 5000.1, "Major System Acquisitions," July 13, 1971 (latest version issued January 18, 1977); and DoD Directive 5000.28, "Design to Cost," May 23, 1975.*

model for evaluating design proposals. The third criterion, intelligibility, is ensured by a structure that makes explicit the paths from the data to the conclusion of the evaluation. The fourth criterion, equity, is promoted by an evaluating mechanism that is comprehensive in including all possible considerations known to be relevant prior to evaluating a design proposal and is flexible in allowing the incorporation of any unforeseen but relevant factors into the evaluating mechanism. Both criteria ensure that arbitrary stipulations do not bias the evaluating mechanism against distinctive design proposals allowed by the latitude of the DTC RFPs. An evaluating mechanism meeting these standards permits the military service to justify its selection or contractors to challenge it on a rational and constructive basis.

Implementing DTC

To meet these demanding criteria under DTC acquisition policy, research was undertaken by a private consulting firm[2] to develop an evaluating mechanism suitable for application to a current problem in evaluation. Because the resulting MAU model for evaluating the Navy's EW System marks the first implementation of DTC acquisition policy in the design phase of the procurement cycle, a brief account of its origins and use is appropriate.

> **"There are essentially two kinds of approaches to evaluation: global and decomposed."**

Although the MAU model was employed throughout the entire evaluation, it was most fully developed and most extensively applied in the evaluation only of technical systems utility (TSU) of the suites and of the EW System as a whole. (Other elements of military worth or of cost and management were evaluated somewhat differently.) The MAU model for TSU, to which this article confines itself, was developed during several working sessions between Navy experts and analysts of the consulting firm. Navy experts extrapolated data for performance from each design proposal, incorporated those data if they seemed reasonable, or amended them if they did not. The model established that two quite different design proposals taken as wholes were of approximately equal military worth and were clearly superior to four others. As a result, the contractors offering them were selected for and have now undertaken further engineering development for prototype testing. The use of the MAU model has not been limited to this stage in the procurement cycle, however. Modifications in the original model have led to a revised version that will be used to evaluate and select the better of the two prototypes when they are tested.

The two questions addressed by a methodology for evaluating TSU of design proposals which meets the four criteria are: What is the actual performance of a system built according to its design proposal likely to be? And what is that actual performance worth? The first question requires a prediction as an answer, the second an evaluation. To predict performance of proposed systems, it would be ideal to have a clairvoyant capable of looking into the future and observing the systems' technical effectiveness. Since no such clairvoyant exists, the problem becomes one of making the best-informed and best-reasoned predictions possible. To evaluate the predicted performance of such systems, it would be ideal to have a permanent and absolute standard of value. In lieu of one, the problem becomes that of making the best judgments possible.

> **"Conditioning variables constitute an explicit recognition that the utility or effectiveness of the same measure of performance may change wth a change in the context of that performance."**

The possible methodologies for system evaluation all involve in one way or another both questions. Those questions requiring a prediction should be answered separately from questions requiring an evaluation. Answers to questions requiring a prediction concern the effectiveness of the proposed system; answers to questions requiring an evaluation concern the utility of the proposed system. These distinctions between prediction and evaluation, and between effectiveness and utility, will be observed throughout the rest of this article. However, the problem to which such methodologies address themselves will be regarded as one of evaluation in a broader sense.

Prediction and Evaluation

There are essentially two kinds of approaches to prediction:

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[2] *Decisions and Designs, Inc., McLean, VA.*

- Personal assessments ranging from guesses to expert opinion.
- Predictive models.

The line between the two is not so sharp that models may not be biased in one way or another, and is further blurred by vagueness about the point at which a proposal becomes too complex for a simple personal assessment. Since most evaluation problems in the procurement of military systems are very complex, however, predictive models, because they pool the knowledge of many experts, are preferred sources of predictions. Of these, simulation models are commonly the most effectual means of predicting the effectiveness of proposed systems. The impressiveness of simulation runs in predicting performances, however, is no substitute for evaluating those performances. Since prediction is quite different from evaluation, no amount of performance data can yield a judgment of even so simple a kind as "more is better" without involving, as in this instance, a prescriptive assertion. The point needs to be emphasized because simulation runs, while often desirable in any evaluation of system design proposals, are not themselves a possible methodology for system evaluation in the broad sense of the term; rather, they are a means of making predictions of performance characteristics.

"The impressiveness of simulation runs in predicting performances, however, is no substitute for evaluating those performances."

There are essentially two kinds of approaches to evaluation: global and decomposed. The line between the two is not always distinct because most global judgments result from a few judgments of lesser scope. The difference between them, though theoretically one of degree, is usually clear enough to separate those approaches that are general and implicit from those that are specific and explicit.

A global approach to evaluation consists of global judgments which are ratings of an entire system (or an entire subsystem) on one or more scales and are often accompanied by written explanations. Because the scope of global judgments is very large, there is usually a broad intuitive leap from information to judgment. Nevertheless, in evaluating systems or subsystems that are not complex, a global approach may be entirely adequate and appropriate.

The difficulties of the global approach arise most noticeably in cases involving the evaluation of complex proposals. These include the inability to use all the information available, the instability of evaluating standards, and a variety of biases. As a general rule, the more heterogeneous the information, the lower the quality of the global judgment. Unfortunately, aids for reducing (or eliminating) the impact of these difficulties have been suggested but have not yet proven themselves effective.[3]

A global approach to evaluation of complex design proposals, then, is not presently bound to satisfy at least three of the four criteria for an evaluating mechanism. Although it can discriminate among design proposals, it cannot ensure reliability or intelligibility. Accordingly, there can be no assurance of its equity. These difficulties ultimately result from the broad intuitive leap from information to judgment.

"The two questions addressed by a methodology for evaluating TSU of design proposals which meets the four criteria are: What is the actual performance of a system built according to its design proposal likely to be? And what is that actual performance worth?"

The decomposed approach, on the contrary, is a means of systematically combining information and specific judgments to produce an evaluation of a design proposal. One such approach is known as a multiattribute utility approach; its central principle is to address an evaluation problem by decomposing all the elements relevant to it into the smallest possible subelements and then to combine them, first into increasingly aggregated measures of effectiveness based upon predicted performance characteristics and then into increasingly aggregated estimates of utilities.

The Methodology Selected

To evaluate TSU of the EW System design proposals, the Navy preferred a model using a decomposed approach supported by simulation runs to a model using a global approach supported by simulation runs (see Figure 1).

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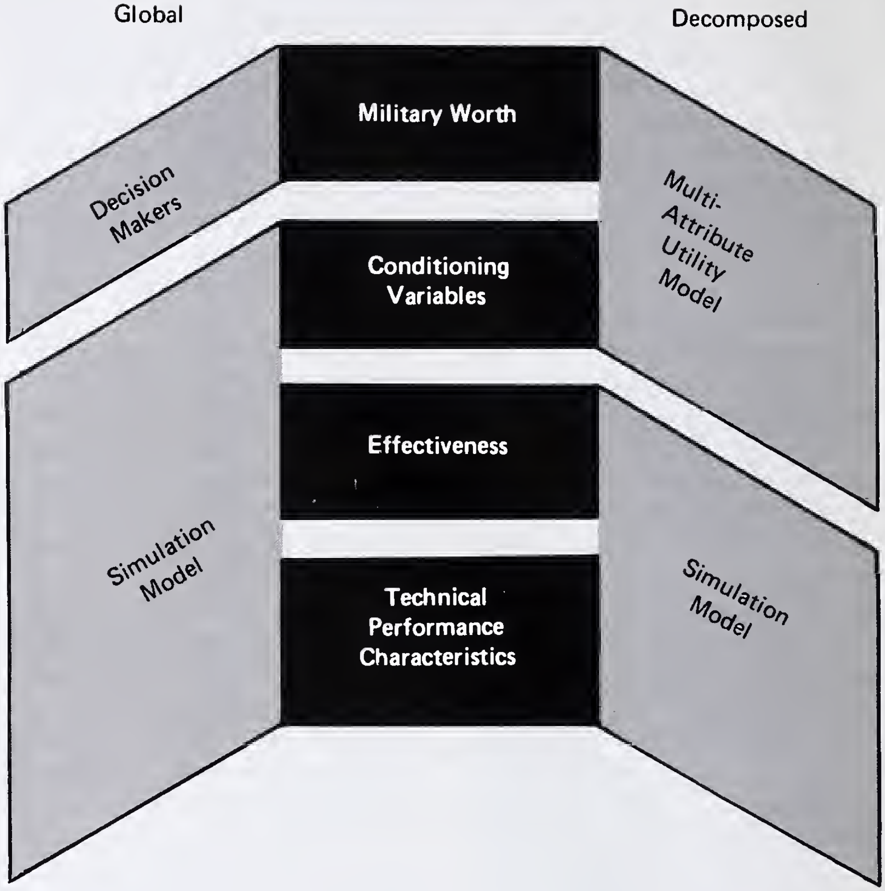
[3] *See, for example, Paul Slovic and Sarah Lichtenstein, "Comparison of Bayesian and Regression Approaches to the Study of Information Processing in Judgment,"* Organizational Behavior and Human Performance, *November 1971, pp. 649–744.*

One of the essential differences between them is that the global approach more extensively employs simulation runs than does the decomposed approach. The use of simulation runs in the global approach extends up through certain contextual aspects of performance. Another difference, of course, is that the global approach attempts to evaluate military worth by means of global judgments, and the decomposed approach, in this case, by means of a formal MAU model.

The Navy preferred the latter approach for basically two reasons. It found that the level of effort necessary to use simulation runs at higher levels would result in a cost exceeding funds allotted for evaluation. And it anticipated that the decomposed —henceforth, MAU—approach would be more intelligible and its results more justifiable than the global approach.[4]

Figure 1. Two Possible Approaches to Complex Evaluations



MAU Model Described

The essential fact about decomposed models, especially MAU models, is that they are explicitly structured to manage information so that one or more experts may contribute to the final evaluation in a logical manner. The structural principle of the MAU model used in this case was hierarchical decomposition; that is, each element of the particular evaluation problem was analyzed into its subelements, each of which in turn was analyzed into its respective subelements, and so on until the most minute subelements of a controllable parameter of performance demonstrably affecting performance were reached. Accordingly, expert opinions may be selectively involved for the appropriate component or subelement. Conversely, predicted levels of performance of the lowest-level subelements in the model may be aggregated until a unique figure representing technical systems utility is determined.

The hierarchical structure of the MAU model consisted of nine levels, six of which are illustrated in Figure 2, the remaining three of which are illustrated in Figure 3.

Level One corresponds to the single figure representing the total worth of each EW System design proposal.

Level Two represents three major elements: military worth, cost, and management, the first of major concern in this article.

Level Three represents the conditioning variables of ship platforms. The five values represent the cost-per-unit ceiling of the five EW suites constituting the entire EW System, each cost configuration associated exclusively with a single class of ship platforms. These conditioning variables are necessary for determining the importance of technical characteristics and aggregates thereof. The MAU model uses these variables in distinguishing the importance of protecting one kind of ship rather than another.[5]

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[4] *The difference between static and dynamic models was not perceived to affect the appropriateness of using such a model for a dynamic process. Although MAU models are usually of a static nature, they can be used to make reasonable approximations of dynamic processes under special circumstances. These occur in the case of EW suites since their weapon delivery times are almost instantaneous.*

Level Four represents eight functional or deployment aspects of a system.[6]

Level Five represents four conditioning variables, each delineating a different scenario describing missions and threats to the completion of those missions. Although a scenario has no value in itself, the model indicates the probability that the situations described will occur and the relative importance of threats to the missions.

Level Six represents four kinds of responses to a threat.

Level Seven represents the operational aspect of these responses.

Level Eight and *Level Nine* represent the parameters of performance associated with a particular aspect of a response in a particular situation.

Note that the heavy line in Figures 2 and 3 represents but one possible thread through this hierarchy. Since there is a large number of possible threads, this hierarchical structure organizes in a manageable way the great quantity of data needed to determine the worth of alternative, complex EW System proposals.

Steps in Model Development

The MAU model is developed in five basic steps:

- Decomposing the evaluation problem into its structured elements.
- Defining element relationships.
- Establishing element boundaries.
- Developing effectiveness curves.
- Determining element weights.

Although these steps must be listed and discussed sequentially, they should be understood to be taken iteratively in practice, especially the last three.

Decomposing the Problem

The first step is to decompose the evaluation problem into its structured elements. The principle of hierarchical decomposition identifies the elements as it structures them, as any analytic process relates parts to wholes. Errors can, of course, be corrected, but their rectification re-

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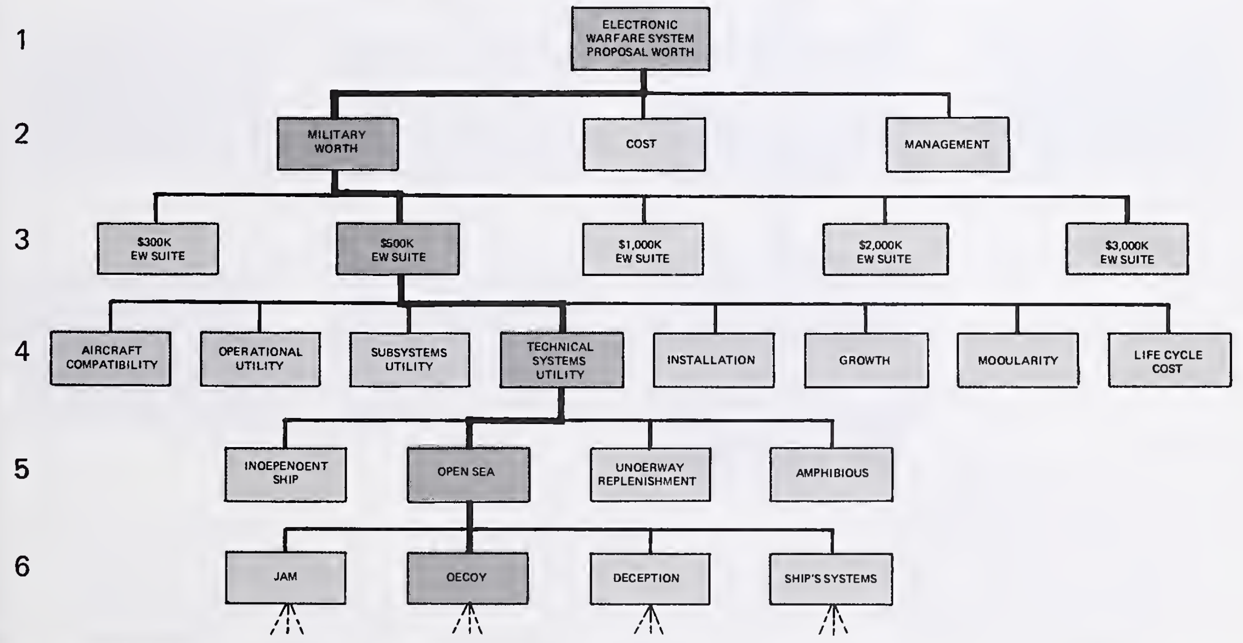
[5] *As it turned out, the evaluation revealed that the Navy maximized military worth by developing an EW system consisting of three, rather than five, suites. It specified one per-unit suite of $1.4 million instead of the three suites with cost-per-unit ceilings of $1 million, $2 million, and $3 million. That suite was estimated to be of greater worth than the two most expensive suites originally proposed.*

[6] *During evaluation, aircraft compatibility was dropped from consideration.*

Figure 2. The Structure of the MAU Model for EW System Proposals



quires a readjustment in all subsequent steps involving structuring related elements.

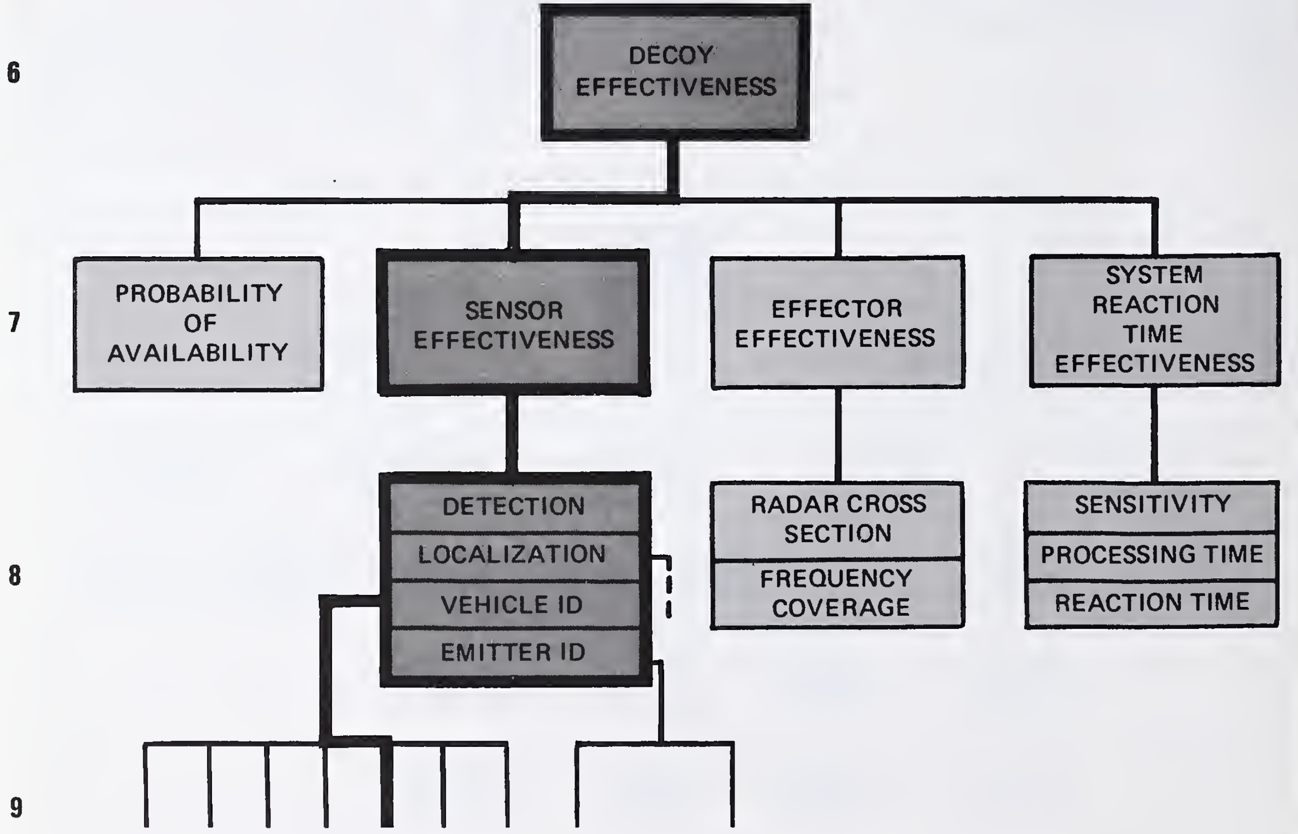
There are two general kinds of elements that emerge in developing an MAU model of TSU:

- The controllable parameters of performance, or the technical characteristics of the systems.
- The factors mediating between these parameters and the aggregate TSU of the EW System.

All mediating factors define the context in which the utility or effectiveness of each subfactor is assessed. One kind of mediating factor is an aggregate of utility or effectiveness which summarizes measures of utility or effectiveness of performance characteristics. For example, one can speak of the effectiveness of a decoy as well as of the effectiveness of its sensor. The other kind of mediating factor is called a conditioning variable, a contextual construct for modeling purposes. For example, although one can speak of the effectiveness of a decoy, one cannot speak of the effectiveness of an open sea scenario. The distinction is drawn between those factors which pertain to the system itself and those which pertain to constraints upon its cost or to the situations in which it is employed.

Conditioning variables constitute an explicit recognition that the utility or effectiveness of the same measure of performance may change with a change in the context of that performance. A conditioning variable is a set of conditions that provides a context in which measures of performance are predicted to occur and are evaluated as a percentage of maximum utility. In the present MAU model of TSU, there are two levels of conditioning variables. The first represents four selected military environments, called scenarios, in which an EW suite may be operationally deployed. Since the MAU model was used to determine TSU of each of five suites defined by their cost configurations (cost-per-unit ceilings), the second level of conditioning variables, the model yields 20 different measures of TSU for each EW System proposal. These

Figure 3. The Substructure of the MAU Model for the Decoy in the Open Sea Scenario



measures permit discriminations of utility for equivalent performance. For example, at the same level of technical performance, the utility of the decoy in the $2 million suite on a cruiser in the open sea scenario might be far greater than that in the $500,000 suite on a destroyer in the amphibious scenario.

The use of scenarios in evaluation, especially in MAU modeling, is necessary as an economical means of predicting and evaluating performance, and of reducing to a manageable figure the infinite number of details required to describe an infinite number of possible futures. Scenarios serve, then, as classifying abstractions; that is, sets of generalized features which characterize a class of possible futures. For purposes of modeling, even this greatly reduced number of generalized descriptions is neither economical nor manageable. Accordingly, a selection of scenarios must be made to ensure that the sampling is representative of situations in which the suites are likely to be employed on the one hand and that the selection discriminates among the design proposals on the other. The procedures for selecting an economical and manageable number of scenarios that are at once representative and discriminating raise difficult methodological questions.[7] Nevertheless, the procedures have been sufficiently developed and refined to enable the selection of scenarios that can serve as a basis for dependable evaluation.[8]

Quantifying the Model

The remaining four steps—defining the element relationships, establishing element boundaries, developing effectiveness curves, and determining element weights—involve a highly iterative process. It goes on continuously and leads to refinements of initial quantifications until the model is satisfactory to those who must use it. Since the model must generate figures indicative of the relative TSU of design proposals, the relationships among the elements as well as their measures of utility and effectiveness must be expressed mathematically.

"The cost-per-unit ceiling and the general absence of performance requirements make evaluating diverse design proposals more difficult than it has been in the past, since all contractors are likely to propose designs meeting the cost-per-unit ceiling."

One of the most important steps in developing the MAU model involves a determination of the rules, or formulae, for representing element relationships within the model. The elements subordinate to the same immediate mediating factor combine to determine its worth (a term used to encompass either utility or effectiveness). The worth of the decoy in the open sea scenario (see Figure 3) is determined by the aggregated worths of probability of availability, sensor effectiveness, effector effectiveness, and system reaction time. The rule for representing the relationship among them must validly capture the manner in which they affect the performance of the decoy in the open sea scenario. In short, the combination rules define the principles of aggregating the worths of elements throughout the MAU model; they capture the value independence of the worths of the elements or the nature of their value dependency. The relative simplicity of the rules themselves belies their sophistication; accordingly, this article avoids the long and technical discussion necessary to explain either the rules or the concepts of value dependence or independence.[9]

Once the combination rules are established (remember that they are amended as necessary as the next two steps are taken), it is necessary to establish element boundaries on ranges of levels of performance of controllable parameters. The purpose of such boundaries is twofold: they limit the range of performance to be measured to plausible dimensions; and they permit the importance of that performance to be gauged realistically. Too often the importance attached to a specific kind of performance is inflated because it is considered universally, without regard to the range of technically and economically feasible levels of performance likely to be suggested by design proposals. This is one point at which the impact of a design-to-cost procurement policy is felt. Thus, whereas an expert may wish the sensor of an EW suite to have a large capacity to detect discrete targets and avoid saturation, he may set a range of targets prior to saturation from zero to 25 and make other judgments with respect to that range, like those for effectiveness curves and weights. However, if design proposals drawn up in light of cost-per-unit ceiling are likely to have capacities from four to ten targets prior to saturation, it is unlikely that the expert will find much difference among the proposals in this respect or attach the proper degree of importance to it. Accordingly, experts must set boundaries based on their best estimates of what range is technically and economically feasible.

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[7] *The subject is discussed theoretically in Michael F. O'Connor and Ward Edwards, "On Using Scenarios in the Evaluation of Complex Alternatives," Technical Report 76–17, Decisions and Designs, Inc., McLean, VA, December 1976.*

[8] *In this case, the Navy reduced an original selection of eight scenarios to four and tested the results obtained from the MAU model by comparing them with the results of a much-reduced number of simulation runs.*

[9] *See Hays, O'Connor, and Peterson, "Application of Multi-Attribute Utility Theory," pp. 21–25.*

Completing the quantification of the model involves two more iterative steps: developing effectiveness curves and determining element weights. It is necessary first to translate measures of performance of controllable parameters into levels of effectiveness expressed as percentages, then to assess the importance of the bounded ranges of performance. The translation is achieved by having the appropriate experts assess the levels of effectiveness (on a scale of zero to 100) for varying levels of performance within previously defined boundaries. The result is an effectiveness curve, a graphic representation of the relationship between levels of performance with respect to a mediating factor, and effectiveness (see Figure 4). The significance of an effectiveness curve is that performance is immediately related to and cannot be considered apart from the context in which it occurs. The curve itself means that performance is seen as a continuum over a range of levels of performance; a particular level of performance is but one possibility within the range of plausible levels of performance, not a point immutable. Similarly, effectiveness varies with the range of levels of performance; many levels of performance within the previously specified boundaries have some, though less than optimum, effectiveness with respect to the mediating factor. Effectiveness, then, is an intraparametric measure of worth throughout the plausible range of levels of performance.

"One of the most important steps in developing the MAU model involves a determination of the rules, or formulae, for representing element relationships within the model."

The use of effectiveness curves has two benefits. First, an effectiveness curve avoids categorizing a particular level of performance as either acceptable or unacceptable, as the stipulation of system requirements demands. Specific requirements can, in fact, be represented by effectiveness curves in which effectiveness is at a minimum when the requirement is not satisfied, at a maximum when it is. Second, the particular shape of an effectiveness curve reveals those ranges of performance in which a slight change in performance may result in a significant change in effectiveness, for better or worse, or those ranges in which a significant change in performance may result in little or no change in effectiveness. The effect of changing levels of performance in terms of TSU can be readily displayed, and the shape of an effectiveness curve may often be diagnostic of that range in which a trade-off between performance and cost is desirable.

The final step in this highly iterative process in developing an MAU model is to determine the relative importance to be assigned to subelements of the same component. As part of the quantification of the model, relative importance (determined by a process called weighting) is expressed as a decimal between 0.0 and 1.0. The purpose of weighting is to recognize the different contributions that subelement effectiveness makes to element effectiveness. Otherwise, the assumption is that the effectiveness of each subelement contributes equally to the effectiveness of the element—which assumption is usually false.

The problem in weighting, then, is a methodological one. Since weights impinge upon the figures for effectiveness and the formula for aggregating them, the difficulty is twofold: how to assess weights and how to incorporate them into existing but as yet incomplete combination rules for aggregating measures of effectiveness. Assessing weights depends upon the relative influence a change in the effectiveness of a subelement has upon the effectiveness of an element, an influence that may be affected by the relationship among the subelements. That is, weights assigned to subelements are a function of their effect upon the element as the effectiveness of each changes from minimum to maximum. Since the assessment of weights depends upon the nature of the combination rules, this technical discussion is also avoided.[10]

Validating the Model

Once the MAU model is developed, two types of validation analyses are conducted. The first, internal validation, consists of examining the effects of variations in weights and effectiveness curves for purposes of identifying critical aspects of the model. This process, known as a sensitivity analysis, has shown that MAU models are usually dependable despite small errors in utility functions or weights. It is also typical that MAU models are sensitive to structural changes resulting from different interrelationships among model factors or to associated changes in combination rules. It is the structure of the model that either does or does not capture the true nature of the problem. Internal sensitivity analyses cannot, however, guarantee this type of validity.

The second type of validation, external validation, provides evidence of the validity of the model structure by using known systems to calibrate the model. The model should assign to these known systems, whose record of performance has been well documented, values that are consistent with the generally accepted assessments of the systems based upon that record. If it does so, it helps to ensure that the model behaves as it should. If not, structural changes are required.[11]

Figure 4. Effectiveness Curve for Detection by the Sensor of the Decoy in the Open Sea Scenario

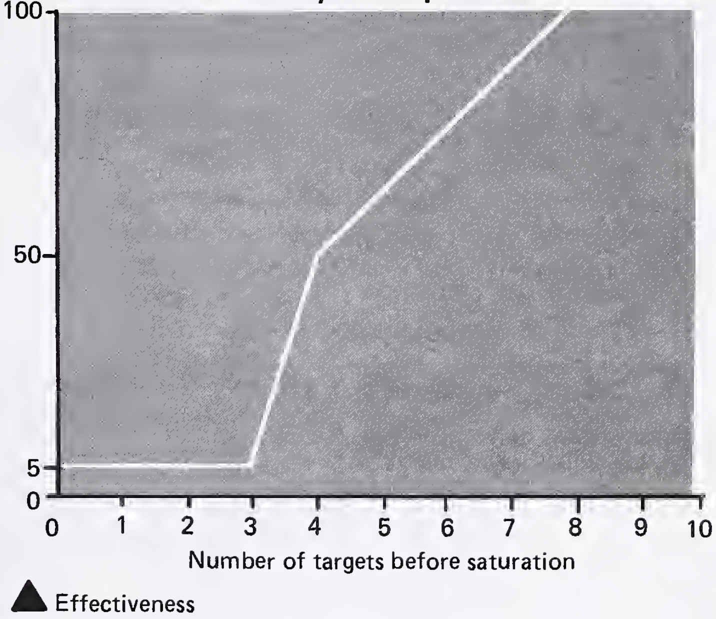

Figure 5. Effectiveness of the Sensor of the Decoy in the Open Sea Scenario

Weight	Subelements	Weight	Parameters	Effectiveness Curves
X	detect			yes
+3%	localize	+90%	DF accuracy	yes
		+10%	elev. (yes-no)	yes
+ +6%	vehicle identification	+40%	frequency	yes
		+17%	PRI	yes
		+ 3%	pulse width	yes
		+ 7%	scan rate	yes
		+20%	correlation	yes
		+ 5%	PCM	yes
		+ 8%	unique char.	yes
+21%	emitter identification	+53%	H/I band	yes
		+47%	J band	yes
+70%	additive constant			no

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[10] *Ibid., pp. 27–29.*

[11] *In the actual external validation of the MAU model, it was found that not enough credit had been given the sensor for its ability to detect false alarms. The model was altered to account for this fact.*

The implementation of such models on interactive computers also allows "what-if" type analyses that can accommodate proposed design changes. Similarly, the model can actually be used to search for those feasible configurations that have maximum utility.[12]

An example of what the completed model is like is suggested by that part of it for the effectiveness of the sensor of the decoy in the open sea scenario, as shown in Figure 5. Effectiveness curves would assess the percentages of effectiveness for the estimated level of performance of smallest parameters. These percentages would be multiplied by their weights, and related products would be combined according to the rule implied by the signs (here, by addition in all cases). The resulting figures for the effectiveness of the subelements or parameters relating them are, in turn, multiplied by their weights, and, again, the products are combined according to the rule implied by the signs. Note in this instance that the figures for three subelements and an additive constant are summed before multiplication by the subelement for detection. (The additive constant in this case says that the sensor has some, potentially 70 percent, effectiveness if it merely detects a target.) By a repetition of these steps throughout and up the model, figures are aggregated until they yield a single figure representing the military worth of an EW System design proposal. Theoretically, if an MAU model completely encompasses those considerations entering into a particular stage of the procurement cycle, a ranking of the figures should select those proposals for engineering development for prototype testing.

Ultimate Benefit

The use of MAU models is not likely to be confined solely to the evaluation and selection of design proposals and prototypes in the procurement cycle. It should be clear that an MAU model can also be used to design a system and diagnose areas in which technological development is worthwhile or not. It is quite likely, therefore, that MAU models will be employed by contractors to assist in the design of other sophisticated and complex major weapon systems. When the use of MAU models becomes commonplace, the military services and contractors will be better able to discuss the performance of major military systems in a systematic manner. For one of the most significant advantages of MAU models is their potential for promoting effective communication. DMJ

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[12] *The MAU model was implemented on computers at the Naval Research Laboratories, Washington, DC, and was used both for numerous "what-if" type analyses in the procurement stages as well as for other design problems on related projects.*

Conflict In Organizations:

Good or Bad

The extent to which conflict is a positive or negative factor in reaching the objective is largely determined by the manager's perspective.

We live in an age saturated with many forms and intensities of conflict. The term conflict is used to describe important differences between individual human beings or groups of human beings. Conflict is a major organizational reality. Typical of this conflict is the breakdown of communication that can occur between management and labor, between a commander and his troops, or between a subordinate and a supervisor.

In our age of dynamic change it is imperative that the manager understand some of the basic causes of, and various strategies for dealing with, the conflict which inevitably occurs in organizations. Not all conflict is bad. Differences which result in initiative and creativity are stimulating for those involved, and such conflict is essential for progress.

Nations, organizations, and groups are made up of individual human beings. Through life experiences, each human being has developed a set of values and evolved a set of behavioral

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rules. These values and rules are sufficiently alike in a given society to allow justice, morals, and ethics to exist and create general agreement about what is right and what is wrong. But the value-rule set for each individual is a unique set not fully shared by others. These differences in value-rule sets are, most likely, the basic causes of conflict. An airman, for instance, might be incensed over what he considers a wrong since the base commander has denied him and his family base exchange check-cashing privileges because a series of bad checks resulted from a pay record error. However, the base commander, bothered by numerous bad check experiences through the BX, may feel it wrong *not* to punish such occurrences.

Another cause of conflict is the motivation of separate individuals. Each is motivated by a peculiarly unique degree of satisfactions in a set of needs. It is quite likely that in a given group situation the individuals concerned will be aiming their personal efforts at slightly different objectives; such objectives may be similar enough to permit cooperative effort but sufficiently different to create some conflict. A common example might be the hot line, employed by many commanders as one of several means of staying in touch with the troops. This opportunity to short-circuit supervisory channels often antagonizes intermediate managers, who may learn of a problem only when the commander confronts them with it. Then, too, it is possible for all to be motivated to behave toward the same goal accomplishment but to feel that that goal, when attained, will not be great enough for all to share adequately in the reward. Conflict may then exist as each strives to attain his place in the sun.

A third major, and more obvious, cause of conflict is found in the differing ideologic and philosophic bases we possess. These relate to a great extent to the value-rule set but are sufficiently different to warrant recognition as possible conflict causes. What we use as a base for our ideals and our concepts becomes of great importance to us, and we do not want that base challenged or questioned by others. An example is the old-timer's reluctance to change from a thus-far successful technique even though evidence indicates that a change would be beneficial. When we perceive attack on our ideals from another, we respond energetically and often heatedly. Note the actions of some militant minority groups and you observe ideologic/philosophic conflict relations at work.

Effects of Conflict

Conflict has both positive and negative effects. It can be positive when it encourages creativity, new looks at old conditions, the clarification of points of view, and the development of human capabilities to handle interpersonal differences. All of us have experienced a surge of creativity when we permit the ideas of others to trigger our imagination, as for example in a brainstorming session. Conflict can be negative when it creates resistance to change, establishes turmoil in organization or interpersonal relations, fosters distrust, builds a feeling of defeat, or widens the chasm of misunderstanding. Such might be the situation today in American society relative to school busing.

Unfortunately, the term "conflict" has only the connotation "bad" for many people, so much so that they think principally in terms of suppression, giving little or no attention to its more positive side. One author emphasizes this by stating: "It seems entirely likely that many, if not most, organizations need more conflict, not less."[1] Another states: "The absence of conflict may indicate autocracy, uniformity, stagnation, and mental fixity; the presence of conflict may be indicative of democracy, diversity, growth, and self-actualization."[2] Some social critics relate the military to the former by their references to the military mind in which they equate absolute and unquestioning obedience with normal military functioning.

Conflict should be considered, conceptually, as neither bad nor good, wrong nor right. The meaning of conflict is established by its participants, since it is people who attach value definition to it. The ultimate results of a conflict situation are determined by the feelings, beliefs, and values of the persons involved. People are the real determinants of the meaning of conflict. If we forget this and treat conflict as though it had some natural quality (good/bad, right/wrong), we overlook the roles of the

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[1] *Stephen P. Robbins,* Managing Organizational Conflict *(Englewood Cliffs, NJ: Prentice-Hall, 1974), p. 19.*

[2] *Leonard Rico, "Organizational Conflict: A Framework for Reappraisal,"* Industrial Management Review, Fall 1964, p. 67.

participants and probably lose the ultimate capability of stimulating conflict.

We are human, though, and it is almost impossible for us to divorce ourselves from feelings, beliefs, and values. We create or get involved in conflict, and we possess predispositions as to how it ought to be addressed or handled. We tend to have a strong behavioral leaning, a set pattern, for our participation, and this emerges as a major factor in setting the nature of conflict. We can note this predisposition for a set pattern of behavior in our tendency to want to apply equal penalties or identical punishment regardless of the cause of an infraction of rules.

We can say, then, that conflict is a state of unresolved difference between two individuals, an individual and a group, or two groups. The difference can be real or imaginary. Regardless, it is a difference and will cause some form of conflict if the involved parties are in contact with each other. The conflict exists until the difference is resolved. The important aspect is how the individual accepts and responds to it, how he seeks to control or stimulate the dynamic conflict situation.

In this age of specialization and sophisticated technology, we can readily find power imbalances in organizations. This often results in conflict. In technically oriented organizations, the managers rarely are able to be experts in all the disciplines or specialties they control. These managers find themselves greatly dependent on technical experts who work for them. Differences arise because of differing knowledge bases and perceptions. Note the hard feelings and accompanying resentment we often experience when a boss, removed from the situation, nitpicks a piece of correspondence we have prepared. Unmanaged, these differences can have negative results. But this need not be if we carefully select mature and adaptable managers who can understand the high degree of informal, expert authority held by subordinates who have technical competence.

The Need to Manage Conflict

We must expect conflict to occur in our organizations. We should be disappointed if it does not because conflict exists only within the context of interdependence. There can be no conflict when there is no awareness of another meaning, role, or value than our own. Thus, conflict is a relationship between segments of an interrelated system: persons, a group, an organization, a community, a nation. There can be no conflict if those involved sense no differences. However, in the environment of interpersonal relationship there will always be differences, and conflict will be the norm, not the exception.

We need to manage conflict in order to obtain profitable return from it. Managing conflict requires that we consider not only the guidance and control required to keep it at an acceptable, yet not too high, level, but also the activity necessary to encourage proper conflict when the level is too low. Who would want to lead an organization without the energy and force accompanying the conflict of creativity and initiative?

Stephen Robbins makes a strong case for the need for a more realistic view of conflict with his interactionist approach.[3] He states that there are three basic managerial attitudes toward conflict which he identifies as traditional, behavioral, and interactionist. The traditionalist believes that all conflicts are destructive and that management's role is to get them out of the organization. The traditionalist, therefore, believes conflict should be eliminated. The behavioralist seeks to rationalize the existence of conflict and accurately perceives conflict as inevitable in complex organizations or relationships. Thus, the behavioralist "accepts" it. The interactionist views conflict as absolutely necessary, encourages opposition, defines management of conflict to include stimulation as well as resolution, and considers the management of conflict as a major responsibility of all administrators. The interactionist view is to accept and encourage conflict. This article uses the interactionist approach.

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[3] *Robbins, pp. 11–21.*

The Person and the Organization

Conflicts occur when the needs and goals of the individuals are not in harmony with the needs and goals of the organization. Chris Argyris, in his discussion of man versus the organization, indicates it is highly conceivable that the traditional goals and structures of organizations may be in conflict with the needs and goals of a developing personality.[4] This may be readily seen in the efficient and omnipotent bureaucracy that places emphasis on hierarchy, specialization of work, established norms of conduct, and explicit rules, often forgetting or overlooking the individual and his unique qualities. Traditionally, personal values tend to be hostile toward organizations, big government, big business, bureaucracy, and, in spite of its purely defensive posture in our country, the military.

Again, conflict can arise when interdependency exists. Employees become dependent on organizations to give their lives direction and meaning. Such dependency allows them to escape the burdens of personal responsibility. Whereas we praise individualism in workers, the organization often requires that the individual be treated impersonally. We see this in "distant" management, in which the people sense an absence of concern for their individuality and personal needs.

Efficiency requirements of the organization also act as sources of conflict because they regularly demand that the goals and needs of the organization be given higher priority than the rights of the individual.

Managing this inherent conflict between individual and organizational needs demands a high degree of self-awareness on my part as a manager. What am I willing to do in balancing these needs? How much can I accommodate comfortably to the need satisfaction of other individuals in my organization? How much faith do I really have in the motivational drives of my subordinates? What really is my role in this unit? What can I do, or what will I allow myself to do, to integrate the needs of the individual with the needs of the organization? In this circumstance that now faces me, which is more important: the individual or the group? No one can preanswer these questions, nor can anyone answer them effectively for another person. Yet the active manager has to answer them as he strives to control conflict.

Never is the functioning organization free of problems. The unresolved problem is a source of conflict because individuals are expected to solve the problem, but the organization (management?) often does not permit mistake or error, or the organization often gives the individual a problem so huge it overwhelms him. Frustration and conflict naturally result. Unless the organization is supportive to the individual's problem-solving efforts, such conflict continues and likely worsens. What is needed, as Harry Levinson indicates, is a supportive environment that gives the individual room to maneuver and freedom to make mistakes, set limits, and define expectations, plus respectful treatment of his ideas.[5]

In many of today's organizations, such a supportive environment is contrary to developed functional relationship patterns. In far too many organizations, for example, mistakes are anathema, and more effort is expended in protective posterior armor than in productive and progressive activity. Fear is prevalent, and the feeling of individual versus the organization is magnified. Many people in military organizations experience this as they find they must guard against inspection visits, staff visits, and the like, at the expense of a ready solution to an immediate problem. In some instances they follow the book, even knowing it to be in error in a given situation, because they cannot anticipate support for an innovative action.

An additional source of individual versus or-

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[4] *Chris Argyris,* Personality and Organization *(New York: Harper Torchbooks, 1957), Chapters III and VII.*

[5] *Harry Levinson,* The Exceptional Executive: A Psychological Conception *(Cambridge, MA: Harvard University Press, 1968), pp. 204–7.*

ganization conflict is generated by the atmosphere of the "new man" versus the "old man." The innovator is always in a less supportive environment than the entrenched old hand. Interpersonal conflicts of the old and new vary in intensity in relation to the ability of the manager to deal with such conflicts and his personal desire to benefit from innovative ideas. But the new is not always right, and we must rationally evaluate these old versus new arguments. Frederick Herzberg speaks to this point in his recommendations for management's referral use of "the wise old Turk,"[6] a valuable source of information already on the payroll.

Reactions to Conflict

Since conflict may be positively or negatively evaluated, there may be a range of reaction to it. These reactions might go from high expectation and pleasure to absolute rejection. In a very broad sense, the individual in a conflict situation has only two options: sign up or ship out.

Rejection of the conflict situation may result in shipping out, a resignation which may be temporary or permanent. The response might be as mild as taking a few days of respite, thus the therapeutic value of leave, vacation, and recreation. Perhaps, in certain organizations, it would be a sabbatical or volunteering for special duty in a new environment. Then, too, it might be total severance, with the goal of a fresh start in a different organization. Or, it might be using the personnel system to find a clean start through internal transfer to another subelement of the organization.

Acceptance of the conflict situation might be manifested in a surge of initiative, a flow of creativity, or a push for productivity. These efforts might result from stimulation of perceived differences, or they might be the observable behavior representing a strong desire for promotion and, thus, escape from the conflict. The net effect may well be good for both the organization and the person.

Means to Resolve or Reduce Conflict

Basic to other considerations in dealing with conflict, conflict resolution requires that the parties in conflict trust each other and that they are able and willing to locate the source of the conflict. Then too, since a man convinced against his will is not convinced,[7] we can generally eliminate the archaic, although often-used, hammer on the head method. Putting the lid on conflict does nothing about eliminating its source.

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[6] *Frederick W. Herzberg, "The Wise Old Turk,"* Harvard Business Review, *September-October 1974, pp. 70–80.*

We might, in a conflict situation, do nothing about it. What would be the result if we decided to take no action to deal with conflict that has been discovered to be bad for the organization? If an individual or group remains in conflict, there will be increased tension that sooner or later will result in one striving to win and drive the loser out of the situation. Even worse, the losing element may become increasingly more aggressive or hostile and counterattack the element frustrating it. At any rate, the result is likely to be dysfunctional. So, as a normal thing, the decision to do nothing is probably not the best. However, the manager on the scene must make this determination. He must understand that there are times when the decision to do nothing *may* be best. This decision can only be made by someone in the situation evaluating the forces and strengths involved.

A frequently used method for resolving conflict is the use of superordinate goals. For example, the entire work force, taken as a whole, is something of a superordinate goal uniting conflicting groups beneath the umbrella of that goal. The manager gets the groups to see how the conflict serves to reduce productivity, thereby reducing the smaller group's stake in the benefits of the major organization's success. Even though the source of conflict is not treated, it is an important first step because it sets the stage for compromise. This approach is similar to the common enemy approach, wherein groups in competition find unity viewing an outside group as a common enemy. This unity can hide, or make less important, conflicts within the group.

A unique method to resolve conflict is to increase interaction between conflicting groups by physically exchanging persons between conflicting groups. For example, if the gizmo unit is having difficulty dealing with the gadget unit, a temporary shifting of people between these groups could help the conflicting elements learn the other's problems and frames of reference. The result should be better communications, greater understanding, and less future conflict.

The quickest resolution is a confrontation meeting. The manager should be warned, however, that confrontation requires complete preparedness on his part. He must have the facts of the conflict situation and confidence in his self-control and his ability to use diplomacy, tact, and problem solving. Even then, he must also accept the possibility that a confrontation may worsen the situation. Basic to his efforts to resolve or reduce the conflict must be the idea of avoiding win-lose situations. Sports and other recreational activities often acquire their flavor by win-lose situations, but the same win-lose options are not always desirable in organizational functions. Far too often in organizations, this results in suboptimization. A subelement may become so involved in winning that it loses sight of the overall mission of the larger unit it serves, and its efforts become counterproductive.

Most complex organizations have reward systems based upon collaborative effort. The organization that depends upon coordinative, cooperative work may be mortally wounded if its subelements acquire win-lose attitudes which cause these suboptimizing activities. Once the stage is set by the manager, he may initiate negotiation by representatives of the conflicting groups. During this negotiation, the manager may wish to use an impartial judge or arbitrator to listen to arguments from both sides and seek to find points of possible agreement or compromise. Of course, we recognize this as the usual last resort in management-labor difficulties and severe conflict situations.

There are situations in which the manager must seek to repress conflict. This is especially true when the differences between the conflicting elements are not relevant to the organizational task. This occurs when two participating people have off-the-job differences which they permit to enter the world of work. Normally this type of conflict is bad for the organization. Often these differences are petty and self-serving, thereby causing activity in which the participants try to win to preserve the sanctity of their original stand. A significant aid to the manager in this form of conflict is a well-developed understanding of the human

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[7] *For an interesting account see Captain Paul B. Ryan, USN (Retired), "USS Constellation Flare-up: Was It Mutiny?" United States Naval Institute* Proceedings, *January 1976, pp. 46–53.*

process of perception, the process by which we handle stimuli in accordance with our values, rules, wishes, and fears. With this understanding, the manager might be able to explain to the conflicting parties how they are misreading the situational data. He might then obtain agreement of a sort that causes the conflict to be repressed.

All conflict is not bad. There will be times when a manager wants conflict of the right type; therefore, it would be advantageous for him to know some means to stimulate it. In a number of instances, he might strive to create the situations he earlier worked to eliminate. For example, he might create win-lose situations in which a form of competitiveness might be engendered. This often works in such areas as selling an idea, recognizing the creation of new approaches to organizational success, and so forth. One means to do this is to deemphasize the need for everyone to contribute to overall organizational success. That is, the manager begins to emphasize the accomplishments or performance of individual people or separate units in lieu of stressing the performance of the whole. He must be cautious, though, to avoid creating a monster that becomes an even greater problem than the absence of productive conflict.

Individuals are the creative segments of society. True, the synergism of two or more individuals often makes us think of organizational creativity, but it really is the individual who creates. Therefore, stimulation of creative conflict can be obtained by increasing the autonomy of individuals on their jobs. A less demanding imposed structure, granting more freedom for the individual to choose and decide for himself, usually creates an environment in which the creative nature is fanned to flame. Similarly, a decrease in supervisory overhead (a widening of the organization) can accomplish this result. Again, though, the manager must remain in control of the situation lest it get out of hand. It is sometimes easy to forget the real goals of the organization as we get enmeshed in the thrill of innovation.

Conflict is a state of unresolved difference between two entities, human or organizational. Sometimes the difference is functionally productive, as with creativity; but sometimes it is dysfunctional, as with war or sabotage or other less drastic confrontations. Conflict should not, therefore, be considered naturally bad or good. It will be bad or good depending upon the value base of the interpreter. But conflict of some form is inevitable whenever two or more human beings are in some interdependent relationship. The important aspect of conflict is how the human participants relate and respond to it. Managers must control conflict. That is, they must keep dysfunctional conflict at an acceptable level, but they must also learn to stimulate functionally productive conflict when it is at too low a level. DMJ

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Reaching A Supply Efficiency Peak Through Selective Management

By investing more heavily in its faster-moving stock, the Defense Electronics Supply Center achieved the best efficiency record in its history during a recent two-year period.

What does an electronics item have in common with a pair of overalls? Not much. But drawing on a simple and logical business principle used in selling overalls helped the Defense Electronics Supply Center in Dayton, Ohio, achieve the best supply efficiency record in its history during a recent two-year period.

Like the other five supply centers under the Defense Logistics Agency, DESC operates on a revolving stock fund basis, whereby materials are "sold" to military and civil agency customers at cost plus a surcharge to cover operating overhead.

Since new stock is purchased with sales revenue, too much money invested in slow-moving items reduces the ability to replenish fast-moving stock. By the same token, extra money put into fast movers increases the total stock availability.

by Stephen A. Stromp, Jr.
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With this in mind, DESC adopted the philosophy of "buying most of what sells best." As a result, the Center's stock availability rate, that percentage of requisitions that could be completely shipped upon initial review by DESC, rose substantially during fiscal years 1975 and 1976 while the volume of backorders declined markedly.

The Management Approach

The system employed by DESC to manage its multimillion-dollar inventory of over half a million electronic items is essentially the same as approaches used by most supply activities, but the Center is distinctive in its style of management and the degree of intensity with which it is applied. Rather than buying "more" of what sells best, DESC buys "most."

The concept is patterned after proven retailing methods which apportion investment relative to sales. As related by Robert L. McBride, deputy director of supply operations at DESC, "I was first introduced to the method years ago while working part-time in a department store. I noticed we were never out of stock of size 32/30 overalls. Being a rural community, jeans were a hot seller, and on Friday evenings we always stocked the shelves with 32/30s in anticipation of Saturday's business. But 52/28s were another story. We may have carried one, but never more than three because of very minimal demand."

Through this approach of placing money on the movers while also keeping enough low-demand stock on hand to assure proper support to the customer, DESC has climbed the logistical ladder in stock availability without an across-the-board investment in inventory.

According to McBride, DESC was placed under stringent funding constraints in 1973. The challenge of keeping shelves filled and stock available at a respectable level demanded innovative management. Following a series of deliberations, DESC decided to "business-orient" its inventory management process by increasing stock levels on high-demand items and taking a calculated risk with less material of limited interest.

The practice was instituted under a frequency management plan known as the DESC Selective Management Category Code Program. Through SMCC, items with the greatest influence on DESC's business were identified, permitting the Center to meter its investment and to plan and control its inventory more efficiently. The ultimate objective was to buy most of what sells best.

Inventory Categorization

The SMCC Program divided DESC's inventory into six coded categories of items, based on the number of requisitions received and the annual dollar value of sales (see Figure 1 on p. 56). This categorization exercise answered two basic questions concerning the activity of each DESC-managed item: How often? How much?

When comparisons were drawn, the items in categories A, B, C, and D, the high and medium frequency items, emerged as the items providing the greatest portion of DESC's business activity (see Figure 2 on p. 57*). Although items in the high and medium frequency ranges represented only 7 percent of the total stocked items managed by DESC, they accounted for a hefty 75 percent of the requisitions and 74 percent of the sales. Conversely, the SMCC F items represented about 92 percent of the stock, yet accounted for only 25 percent of the requisitions and only 5 percent of the sales.

A DESC inventory management specialist reviews supply control data relating to one of the 174 SMCC-coded connector items managed on a selective basis.

Recognizing the heavy influence of SMCC A and B items on DESC business, the Center began profiling these items to establish characteristic patterns and to supply the management attention needed to keep SMCC A and B shelves filled. Some of the more pertinent features uncovered by the probe about SMCC A items, both individually and collectively, were as follows:

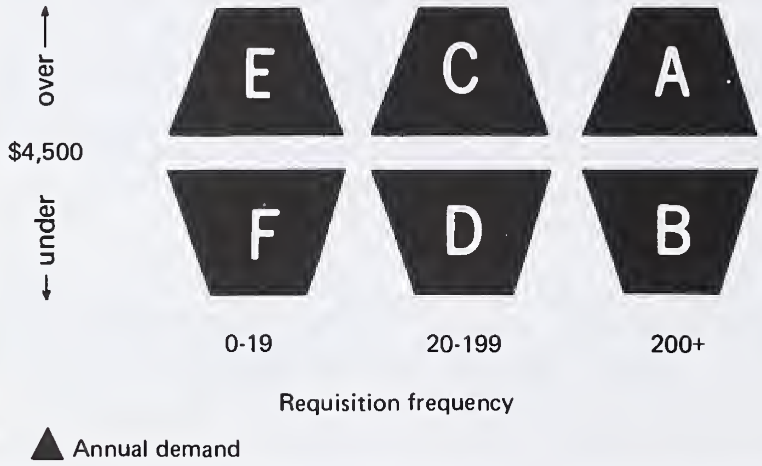
- There were 700 requisitions per year per item.
- 80 percent of the items were used in weapon systems.
- 20 percent were only available from a single source of supply.
- 70 percent of the items required an administrative lead time of 60 to 120 days.
- 50 percent of SMCC A's required production lead times of 150 days or more.

On the other hand, the profiling process disclosed that SMCC B's had their own behavior pattern:

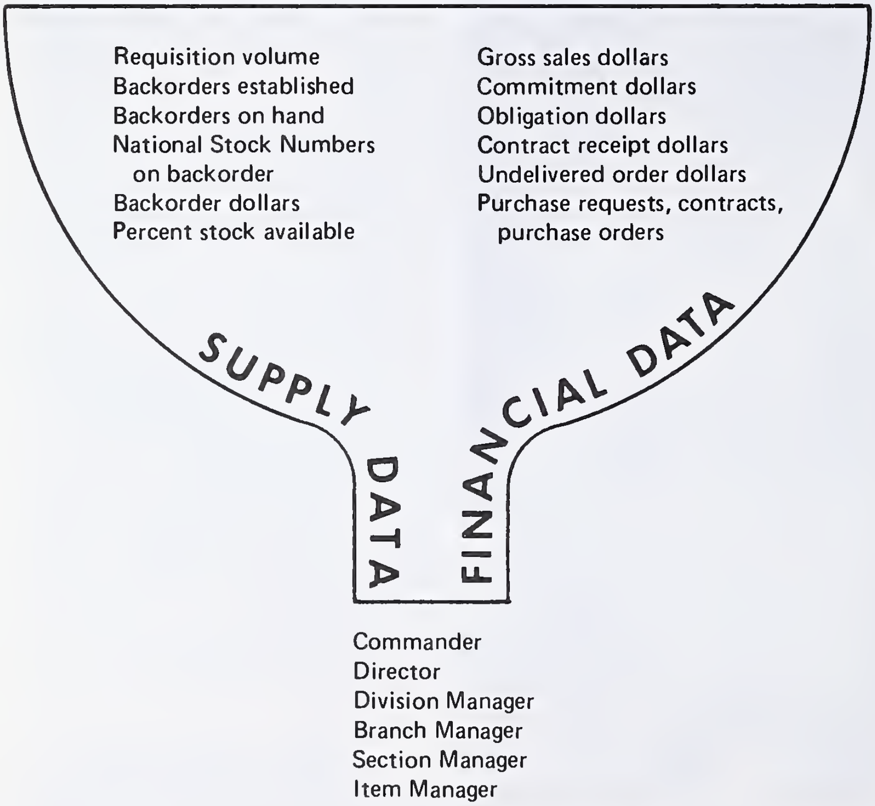
- As a group, the items had very low unit prices.

**The vital statistics in Figure 2 were used by DESC as a guideline in establishing its SMCC program. They are provided here so that parallels can be drawn for other commodities as well.*

Figure 1. Coded SMCC Categories



Data Funneling



All organizational levels are alerted to potential problems through DESC's management information system.

- There were 360 requisitions per year per item.
- 80 percent of the items were used in weapon systems.
- Only 9 percent were identified with a sole source of supply.
- 30 percent reflected an administrative lead time of 60 to 120 days.
- 33 percent had production lead times of 150 days or more.

In essence, the profile demonstrated that SMCC B's were less expensive and created less fuss; even though the requisition volume was half that of SMCC A's, B traffic was still substantial. Therefore, it was determined that shepherding B's as well as A's would significantly drive stock availability upward.

Using Money and Manpower Wisely

The crux of supply management is knowing how and where to invest manpower and monetary resources. Managerially, higher-grade inventory managers are assigned A, B, C, and E items, while mid-grade managers attend to D and F items. This permits developed skills to be used to the fullest. Financial resources are allocated to categories according to essentiality factors defined by the DoD variable safety-level computations. Determined through operations research simulation studies, these factors have the effect of weighting the amount of safety-level investment each category receives.

Because of their more predictable demand pattern, SMCC A and B items provide a greater return on investment in terms of stock availability than the more unpredictable and costly SMCC E items. Consequently, DESC puts a greater weight on SMCC A and B safety-level investment through the use of the essentiality factors than it does on the SMCC E items. But this isn't a case of "robbing Peter to pay Paul" since DESC squeezes as much customer support as possible from every supply dollar spent. This allows DESC to maximize its total system stock availability with a minimum investment of safety-level dollars.

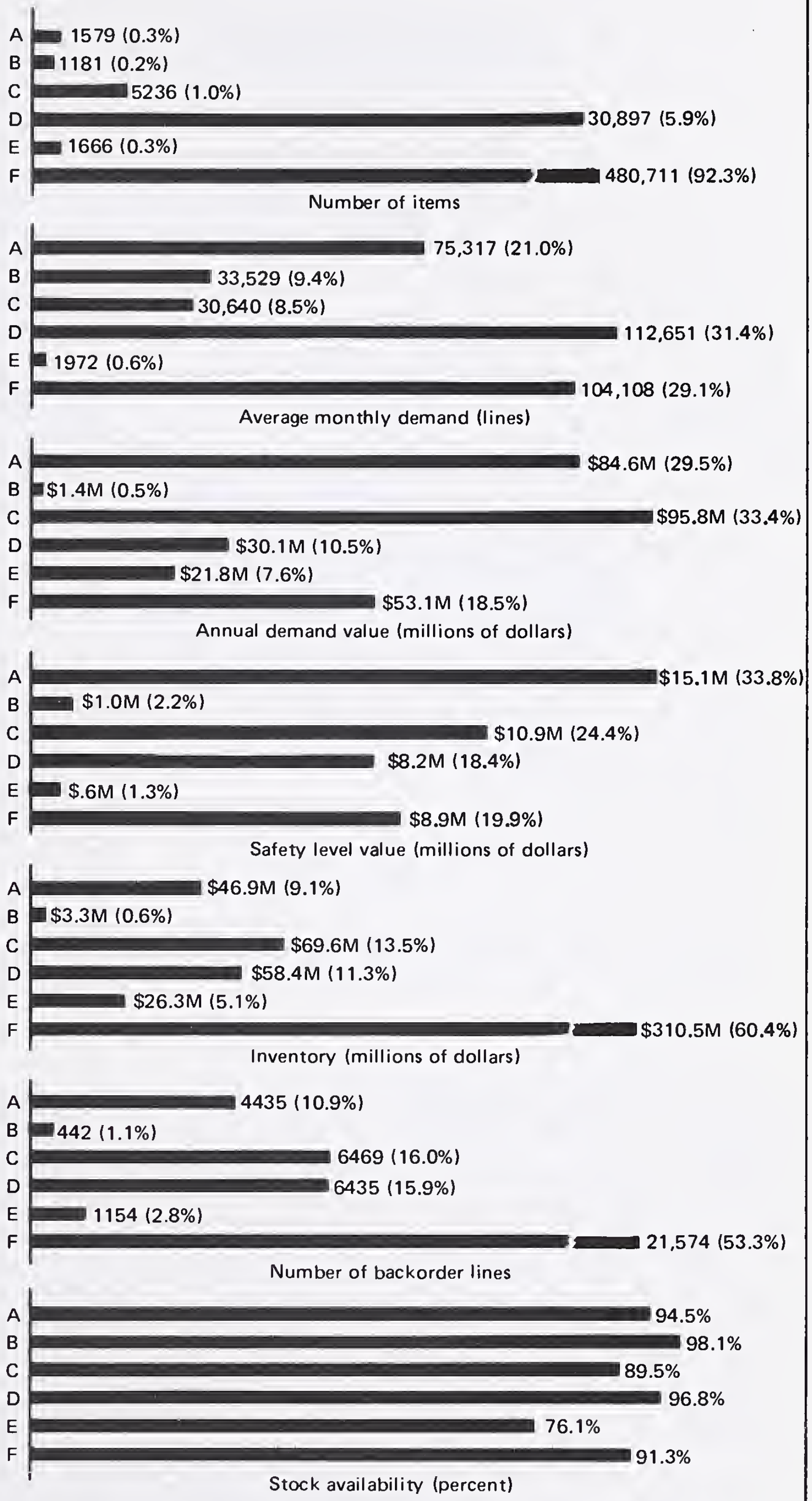
Results to Date

One of the difficulties in managing an inventory of DESC's size is avoiding an overinvestment or underinvestment in stock. While the situation may appear well-managed across-the-board, there is often costly overinvestment on one item and underinvestment on another. However, through SMCC, DESC has achieved greater parity and is much closer to its ultimate goal of paralleling investment with demand.

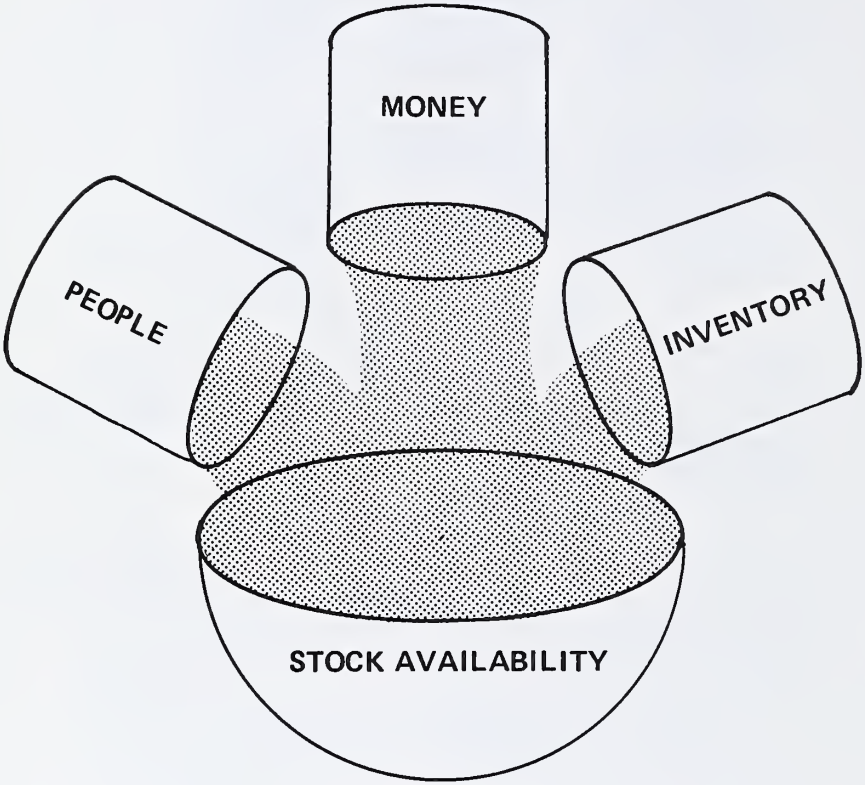
In terms of customer support, SMCC has been quite effective in giving DESC maximum mileage from its stock fund dollars. During FY 75 and FY 76, stock availability rose from 88 percent to 94 percent, while backorders fell from a record high of 117,500 in May 1974, to a record low of 39,200 in July 1976.

Administrative lead times on most SMCC categories dropped markedly the last year, helping to reduce DESC's lead-time investment by $7.4 million, or 10.1 percent. The trend of increasing administrative lead times for SMCC A items was also reversed, indicating improved customer support on these items. Moreover, with SMCC's built-in

Figure 2. SMCC Vital Statistics



Ingredients of SMCC Success



Effective combination of available resources.

sensitivity to changing patterns, such situations never occur unnoticed.

While administrative lead times have improved, production lead times are on the upswing for some of DESC's stocked items, a condition generally attributed to the recent increase in business activity throughout the nation's economy. SMCC A, C, and E production lead times are typically longer than those in the SMCC B, D, and F categories because of higher unit costs and higher dollar value of contracts involved. SMCC E items in particular have encountered stretched lead times, but DESC has taken no actions to stem the tide. For instance, SMCC has been integrated into the appropriate computer file which automatically prints the code on purchase requests in DESC's procurement directorate. This permits priority processing of the purchase requests, thereby minimizing administrative lead time on high and medium frequency items. Likewise, item managers have been requested to expedite delivery on contracts for SMCC A, B, C, and D items which may prove troublesome. Finally, SMCC B and D items have been assigned to special item managers who employ selective management techniques which permit them to exercise more adequate control over lead times.

Intensity, Sensitivity

While DESC's Selective Management Code Category Program follows the basic formula of other inventory management concepts, SMCC is earmarked by its intensity and sensitivity. Through the comprehensive structure of the program, DESC today knows a great deal more about the variables of its supply business than it did just two years ago. And it is applying the ingredients for SMCC success—people, money, and inventory—accordingly.

Whether to improve support or to circumvent a knotty problem, numerous strategies are available to item managers. But it is essential that they first know what knobs to turn. Through SMCC, the Defense Electronics Supply Center has introduced just such a management discipline.

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A Retrospective Look

The Yesterday, Today, and Tomorrow of Integrated Logistics Support

In its thirteenth year, ILS is surely here to stay; the task for the ILS community is to make that stay a productive one.

While most of the aerospace industry knows about integrated logistics support, it is a much smaller number of practitioners that realize ILS is well into its second decade. Although ILS has changed in form since its inception in 1964, the objective remains to strike an optimum balance between total system performance, cost, and schedule while developing an integrated support system. This article looks at the evolution of the ILS concept, the progress made in implementing ILS, and the challenges still to be met.

The Birth of ILS

On June 19, 1964, DoD Directive 4100.35, "Development of Integrated Logistics Support for Systems and Equipment," was issued to assure that "effective logistics support for systems and equipments is systematically planned, acquired, and managed as an integrated whole . . . to obtain maximum materiel readiness and optimum cost effectiveness." The directive was developed by the DoD Equipment Maintenance and Readiness Council, assisted by the Maintenance Advisory Committee of the National Security Industrial Association. This joint DoD-industry effort made the directive rather unique and demonstrated the universal concern for effective and economical support systems. Although this concern had long been voiced by logisticians, DoDD 4100.35 represented the first official move to improve the development of logistic support systems and as such was a milestone in defense system programming.

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As with all new ideas, ILS was greeted with mixed emotions. DoD and the defense industry had been saturated with "integrated systems," "systems engineering," "cost effectiveness," "system effectiveness," and a seemingly endless list of new disciplines and management philosophies. There were many who felt, or hoped, that ILS would be just another buzz word that would soon be discarded. Others saw the need for such an approach to support planning, but dreaded the inevitable deluge of new regulations, reports, and associated paperwork. ILS, however, did not go out of fashion or result in an unmanageable mountain of ink and paper. It wasn't long before the song of ILS was being sung from every professional circle within the defense community.

One of the first major forums for discussing integrated logistics support was the first Electronics Industries Association Conference on Systems Effectiveness in October 1965. C. W. Winkler of Douglas Aircraft presented a paper which highlighted the seven basic elements of the ILS concept (Figure 1) as defined in DoDD 4100.35. Some of the key points were:

- ILS is necessary for the development of an effective and economical support system.
- For the most part, the cost of ownership of weapon systems far exceeds the development and investment costs.
- The cost of ownership of weapon systems is most effectively controlled by emphasis on ILS as early in the conceptual phase of the system as possible.
- ILS represents the start-to-finish life-cycle planning of total maintenance and logistics support of weapon systems.

The next several years saw a continuing interest in and further refinements of the ILS concept. At the First Annual Logistics Management Symposium, George J. Vecchietti of the National Aeronautics and Space Administration gave a first-hand view of the contract strategy then being used or being considered for use by NASA in the logistics support area. Award-fee contracts and early, meaningful pricing of logistics support line items were the two objectives NASA was pursuing to improve logistics support management. At the Second Systems Effectiveness Conference, Ben S. Blanchard of General Dynamics told of the interrelationship of cost effectiveness, system effectiveness, and integrated logistics support. And at the Sixth Annual Reliability and Maintainability Conference, John E. Losee addressed the development of quantitative logistics performance parameters during the conceptual and contract definition phase of Air Force programs.

"The cost of ownership of weapon systems is most effectively controlled by emphasis on ILS as early in the conceptual phase of the system as possible."

These men and countless others helped to better define ILS and to develop procedures and methodology for implementing the concept. In those formulative years, the defense community tried new and innovative management techniques in order to put ILS into the development process.

The first large-scale implementation of ILS involved the B–1 and F–15 programs. The B–1 ILS office was established within the program office as a directorate coequal with the other "standard" directorates (such as engineering, test, and program control). The majority of the officers hand-picked for the ILS team had engineering degrees and experience as maintenance officers or logistics officers. Responsibilities were assigned according to a three-dimensional matrix (Figure 2 shows a representative segment), with each officer given several responsibilities in three areas: logistics elements, subsystem design, and logistics tasks.

"Although ILS has changed in form since its inception in 1964, the objective remains to strike an optimum balance between total system performance, cost, and schedule while developing an integrated support system."

First regarded as just an Air Force Logistics Command liaison office, the ILSO was soon accepted as a working member of the B–1 team and was given program responsibility and authority for the acquisition of the support system. None of this could have happened, however, if the program manager had not recognized the importance of proper logistics planning and afforded ILS the same attention as was given to the other program functions. This same visibility was also afforded ILS in the F–15 program, where the ILSO had the full support of its program manager and was also manned by a select group of individuals with engineering and support backgrounds.

AFALD Established

Such efforts to put ILS into practice were repeated in many other programs, both large and small. But the ILS effort was not restricted to program-level management. AFLC was continually assessing its role in system acquisition and saw a need for more active involvement. In April 1974, AFLC established a Deputy Chief of Staff for Acquisition Logistics responsible for focusing command management attention and resources on procedures, techniques, and activities necessary to implement fully the ILS concept. Two years later, the Chief of Staff directed the establishment of the Air Force Acquisition Logistics Division. Operating as an AFLC subcommand, AFALD has the responsibility and authority to provide strong, constructive advocacy for controlling life cycle costs, and to assist Air Force Systems Command program managers during all phases of the system acquisition process.

> **"The concept of making early, relatively small investments in order to realize a lower life cycle cost is central to the ILS philosophy."**

Compared to the early days of ILS, AFALD represents a considerable change in the management attention and manpower resources dedicated to logistics support. Yet organizational changes have not been the only outgrowth of ILS; DoD Directive 4100.35, supplemented by DoD Guide 4100.35G, has been updated and has spawned several Air Force logistics documents, including an ILS implementation guide and a regulation dealing with acquisition of support equipment. In addition, the development of policy and procedures for related subjects, such as life cycle costs, has improved the implementation of ILS in systems programs. Today, the original 7 elements of ILS have been expanded to 11, all major programs have an ILS office, and both AFSC and AFLC continue to improve the management and application of ILS.

Despite the progress made since 1964, there still remains much to be done. Some of the early misgivings about ILS persist, and some program managers still have to be "sold" on ILS. This selling job is necessary not to overcome resistance to good support planning, but because of the current management and budgeting environment. Take, for example, the budgetary pressures put on the program manager. Asked to plan several years into the future, he is given money one year at a time; but the exact amount is not known until the budget is approved by Congress. Months of careful planning at the program level can be negated when the upcoming fiscal-year budget is cut. This in turn may require reprogramming, delaying, reducing, or eliminating certain tasks. Deciding which tasks are to be affected is normally done on the basis of immediate need; that is, those tasks needed today, such as hardware design, are kept constant at the expense of tasks which do not have a first-hand effect on the program. Such tasks include ILS, reliability demonstration, development of technical manuals, and related "supporting" tasks. Ironically, these areas with no immediate effect on the program are the determining factors in the downstream operating and support costs.

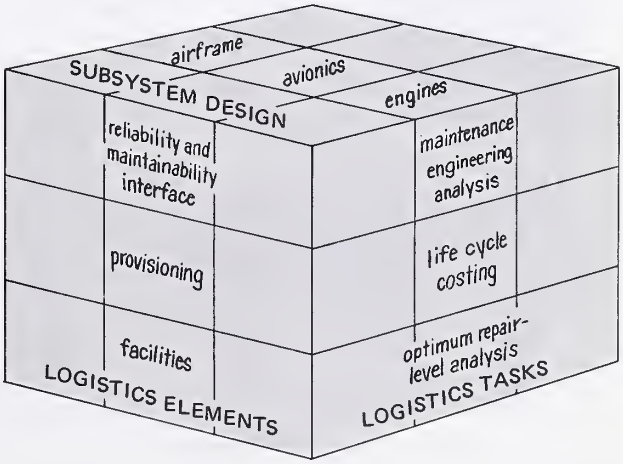
Figure 1. Basic Elements of ILS

- Planned maintenance
- Spares & repair parts
- Support equipment
- Technical logistics data & information
- Contract maintenance
- Logistics support personnel
- Facilities

All too often one is forced to live within today's budget at the expense of higher life cycle costs. The concept of making early, relatively small investments in order to realize a lower life cycle cost is central to the ILS philosophy. Only when ILS is implemented early and afforded a chance to impact design can the intent of ILS be met. Without this front-end investment, ILS can often do no more than develop the least-expensive support system for a patently unsupportable weapon system.

Another obstacle to selling ILS is the desire of every manager to "be certain" before making

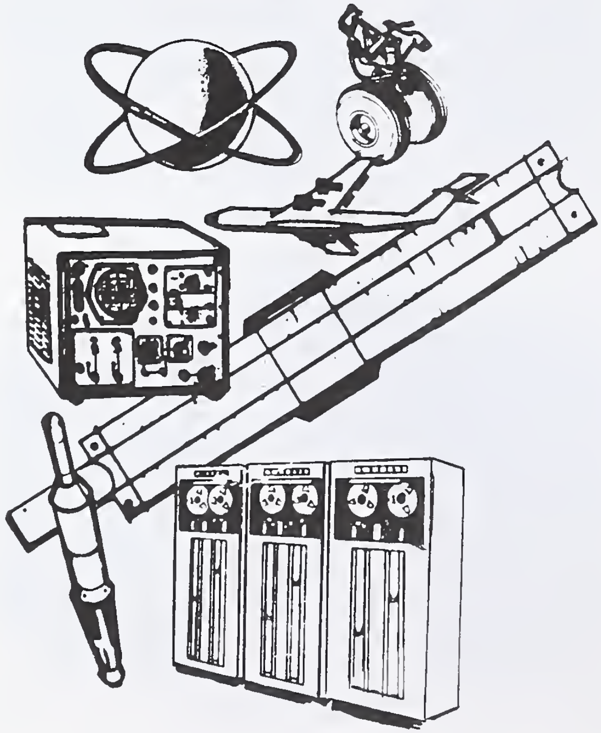
Figure 2. Responsibility Matrix



a decision. All managers would prefer to have all the facts, eliminating all uncertainty before making a decision. A reality of life, however, is that uncertainty is always present, and we never have the time or the ability to know all the facts. We therefore must rely on analytical techniques and our own experience to minimize the effect of uncertainty, and thereby reduce the risk of a bad decision.

> **"Another obstacle to selling ILS is the desire of every manager to 'be certain' before making a decision. . . . The analytical tools developed in the area of ILS, such as logistics support analysis, optimum repair-level analysis, and various cost models, are reasonably accepted as meaningful and useful."**

The analytical tools developed in the area of ILS, such as logistics support analysis, optimum repair-level analysis, and various cost models, are reasonably accepted as meaningful and useful. Still, the validity of any analysis is largely dependent on the accuracy of the data used. Herein lies the dilemma of the decision maker regarding ILS: the early phases of a program, when the ILS analysis is most effective in influencing design, are the times when the data is very "soft." The program manager is reluctant to implement a design change at a cost of, say, $100,000, simply because ILS analysis based on soft data *indicates* an LCC savings of $1 million over the present design. If the decision is delayed until the data is "dependable," change may be impractical because of the implementation cost and schedule impact. The net result is that many of these LCC-affecting changes are not made.

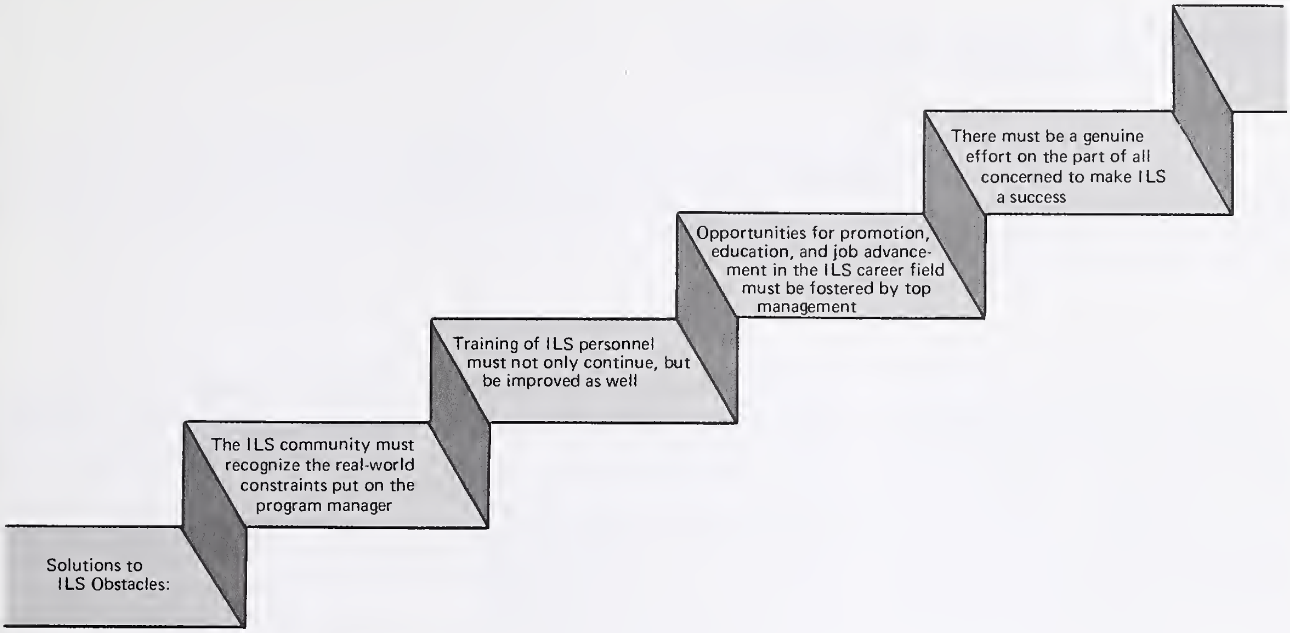


The problems of budget constraints and good data, however, are secondary compared to the lack of adequately manned ILS offices. This manning inadequacy consists of two types: quantity and experience. Many ILS offices do not have the recommended allotment of personnel to develop and acquire a supportable weapon system together with a complete, cost-effective support system. Except for very small programs, a smaller number of people cannot adequately define, develop, and manage an effective ILS program.

The number of ILS personnel could be kept at a minimum if all were experienced both in program management and ILS, but there is a discouragingly small number of these people and many of them move into other career areas after a few years in an ILSO. The average program therefore begins with only a few, inexperienced people to plan and manage the ILS program. With the current emphasis on austere manning and the need for career diversification (to be competitive for promotion), the people problem is not a temporary situation.

Solutions Are Not Simple

Solutions to these obstacles are more easily stated than solved, but there are some basic steps available to improve the immediate situation and eventually eliminate these obstacles. First, the ILS community must recognize and appreciate the real-world constraints placed on the program manager, who is tasked to bring in a program on schedule and within a budget which he only knows a year at a time. With minimal discretionary funds available to him, he is asked to explore alternatives and change the program plan as needed in order to minimize life cycle costs and achieve the operational requirements. He is asked to request more front-end money (he is judged, in part, by his ability


Solutions to
ILS Obstacles:
The ILS community must recognize the real-world constraints put on the program manager
Training of ILS personnel must not only continue, but be improved as well
Opportunities for promotion, education, and job advancement in the ILS career field must be fostered by top management
There must be a genuine effort on the part of all concerned to make ILS a success

to avoid cost growth) to save dollars in the long run, even though he will undoubtedly be somewhere else by then. One need not be imaginative to guess which direction the program manager is inclined to go—control today's costs!

A second step is to continue and improve the training of ILS personnel. The Air Force's Logistics and Systems Commands currently have a program which allows officers in one command to gain experience in the other and then return to their parent command. As a result of this cross-fertilization, the future program manager gains logistics experience and the future deputy program manager gains experience in the total program management area. Eventually, some of the harmful command parochialism should disappear and ILS should become more of a team effort.

"ILS is necessary for the development of an effective and economical support system."

A third step is to make the ILS career field an attractive one. If ILS is to compete with more glamourous career fields for quality, then opportunities for promotion, education, and job advancement must be fostered by the highest management levels. There has been much progress in this area, and the old fear of "being stuck in logistics" no longer is prevalent.

Finally, the obstacles to ILS can be eliminated through a genuine effort on the part of all concerned to make ILS work! This includes the program manager, the air staff, the developing and supporting commands, and the Congress. The program manager must have the courage to make the hard decisions, and higher management must encourage and support the program manager in such decisions. The commands must make ILS a true objective, not at the expense of other requirements, but as an equally important and vital requirement. Congress must understand and encourage the ILS effort and should consider alternate funding approaches for system development and acquisition (such as multiyear funding).

Integrated Logistics Support has come a long way over the past 13 years. It is a concept that is here to stay. The task for all involved is to make that stay a productive one. DMJ

MAJOR NED H. CRISCIMAGNA, USAF, is a Reliability and Maintainability Staff Officer assigned to the Logistics Engineering and Support Division, Directorate of Maintenance, Engineering & Supply, under the Deputy Chief of Staff for Systems and Logistics.

He was previously assigned to the Directorate of Aerospace Logistics, part of the Air Force Acquisition Logistics Division.

Major Criscimagna has a B.S. degree from the University of Nebraska and a Master's degree from the Air Force Institute of Technology. He is also a graduate of the Air Force Command and Staff College, and has completed the National Security Management Course conducted by the Industrial College of the Armed Forces.

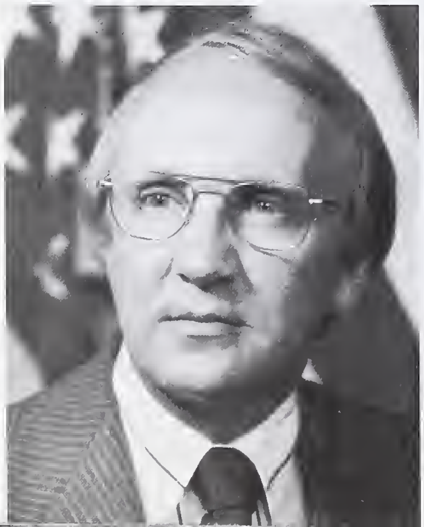
Who's New in DoD

Their decisions will have significant impact on Department of Defense planning and policies. For the most part, however, their names and faces are relatively little known to persons in DoD. In this issue, the **Journal** *offers brief introductions to newly appointed managers in the Military Departments.*

Robert L. Nelson is the Assistant Secretary of the Army (Manpower and Reserve Affairs). When nominated, he was president of the Broadcasting Division of Washington Star Communications, Incorporated, which he had joined in 1974 as the newspaper's senior vice president (treasurer and counsel).

He was employed by various government organizations from 1958 to 1966, serving consecutively with the U.S. Commission on Civil Rights, the U.S. Agency for International Development, and the U.S. AID Mission to Brazil. Subsequently, before joining Washington Star Communications, he served in legal and management capacities in private industry.

Mr. Nelson, 46, received a B.A. degree from Bates College, Maine, and a law degree from Georgetown University Law Center. He is a member of the Bar of the District of Columbia.



David E. Mann is the Assistant Secretary of the Navy (Research and Development).

From 1951 to 1965, Dr. Mann held positions with the National Bureau of Standards, first as physicist and later as chief of molecular spectroscopy. In 1957, he was awarded both Guggenheim and Fulbright fellowships for study abroad.

He joined the Advanced Research Products Agency in 1966, and in 1967 he was appointed deputy director of that agency's Ballistic Missile Defense Office.

In 1968 he became director of the Strategic Technology Office, where he initiated development programs in high-energy lasers, long-range infrared and radar sensors, and undersea and ASW sensor technology.

Dr. Mann became special assistant for Navy advanced system projects to the Chief of Naval Operations in 1973.

He holds a Ph.D. in chemistry from the University of Chicago.

Alan J. Gibbs, the Assistant Secretary of the Army (Installations, Logistics and Financial Management), had been deputy commissioner of the New Jersey Department of Human Services since 1974.

He began his career in public service in 1963, when he entered the management intern program with the National Labor Relations Board as a labor-management relations examiner in Baltimore.

In 1966, Mr. Gibbs joined the Equal Employment Opportunity Commission in Washington, DC. In 1968, he was appointed area director for Alabama and Tennessee.

Mr. Gibbs, 39, was assistant health services administrator in the New York City Health Services Administration from 1970 to 1972, when he became first deputy commissioner of health.

He holds a B.S. degree in management and an M.S. degree in labor and industrial relations from the University of Illinois.

Antonia Handler Chayes is the Assistant Secretary of the Air Force (Manpower, Reserve Affairs and Installations). At the time of her nomination, she was a partner in the Boston law firm of Csaplar and Bok.

Her professional experience includes the deanship of Jackson College, Tufts University. She was a lecturer in law at Yale and Boston University law schools.

Ms. Chayes served as Director of Education and Urban Development for Action for Boston Community Development, and as liaison for the Boston Model Cities Administration. She was also a member of the planning staff of the National Institute of Mental Health.

She was a member of the White House staff in 1961 and 1962.

Ms. Chayes, 48, received an A.B. degree in government from Radcliffe College and a J.D. degree from George Washington University.

Edward Hidalgo is the Assistant Secretary of the Navy (Manpower, Reserve Affairs and Logistics).

Mr. Hidalgo was a legal advisor with the State Department from 1942 to 1943.

He was a member of the United States Delegation to the Inter-American Conference in Bogota, Columbia, in 1948.

From 1965 to 1966, he was special assistant to the Secretary of the Navy, and from 1966 to 1972, he directed the European office of the law firm of Cahill, Gordon, and Reindel.

In 1972, Mr. Hidalgo served as special assistant for economic affairs to the director of the United States Information Agency, and in 1973 he became general counsel of the agency.

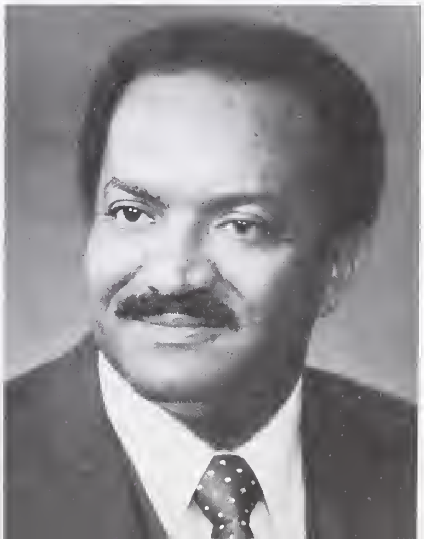
He holds a B.A. degree from Holy Cross College, a J.D. degree from Columbia Law School, and a degree in civil law from the University of Mexico.

Percy A. Pierre, the Assistant Secretary of the Army (Research and Development), was dean of the School of Engineering, Howard University, at the time of his appointment. From 1968 to 1971, he was a research engineer with the Rand Corporation.

Dr. Pierre, 38, was a White House Fellow from 1969 to 1970. From 1973 to 1975, he divided his time between Howard University and the Alfred P. Sloane Foundation.

He has been a member of the Board of Directors of the Engineering Colleges Council; American Society for Engineering Education; and the Advisory Panel for the Institute of Applied Technology, National Bureau of Standards. He served as consultant to the Center for Naval Analyses.

He holds B.S. and M.S. degrees in electrical engineering from the University of Notre Dame and a Ph.D. degree in electric engineering from Johns Hopkins University.



a few words about...

Technological Breakthrough

DLA Develops Laser Labeling System

The Defense Logistics Agency's Defense Depot Ogden, Utah, has developed a system which uses a high-powered, pulsed laser beam controlled by a microcomputer to burn labels directly on shipping containers. Known as the container automatic marking system (CAMS), the new method created by DLA engineers has dramatically increased the speed, efficiency, and accuracy of marking packaged material for shipping.

The CAMS unit is interfaced through a microprocess computer to the depot's computer system. The computer automatically gathers the weight and cube data and assigns the package to a shipment sorter line. When the shipment unit on a particular line is complete, it is released to CAMS for automatic marking. Upon signal, CAMS, by controlled laser burning, prints the destination address directly on the shipping container surface.

The new procedure eliminates several human steps and accomplishes the work 20 times faster than old hand-marking methods.

Estimated costs for a new CAMS system are about $95,000. Anticipated annual savings will be $39,761 on the basis of 650,000 packages marked.

Fundamentals Offered

New Course Teaches OR/SA Skills

A 12-week course on the fundamentals of operations research/systems analysis is being offered by the Army Logistics Management Center, Fort Lee, Virginia. The course is for Army officers who have the OR/SA specialty but do not have a graduate degree in either OR/SA engineering or OR/SA business.

The course is designed to give Army officers an understanding of OR/SA theory and methodologies. It will provide the student with the knowledge and skills required in the military environment to perform and critically evaluate OR/SA studies, interpret them for decision makers, and communicate effectively with systems analysts and other specialists.

The next class of the OR/SA Military Applications Course will begin February 6.

ALMC also is offering a series of short, intensive seminars to provide experienced OR/SA officers with information they may not have received during their formal education process.

For further information, write the Chairman, Systems and Cost Analysis Department, School of Logistics Science, ALMC, Fort Lee, VA 23801. Phone: (804) 734–1231.

DMJ Rated Outstanding

The *Defense Management Journal* recently received a Blue Pencil Award for editorial excellence from the National Association of Government Communicators. The award was bestowed in competition with other government publications whose professional staffs are comparable in size to that of the *Journal.*

The NAGC is the professional organization for information and editorial people at all levels of government—federal, state, and local.

ASPR Discussed

Proposed Bill Modifies Procurement Regulations

A recently introduced Senate bill, "Federal Acquisition Act of 1977" (S 1264), would have far-reaching effects on defense procurement. The bill contains recommendations for eliminating the separate DoD procurement regulations (ASPR), requiring functional specifications and life cycle costing for procurements in addition to major systems, giving final authority to the General Accounting Office in bid protests, restricting the use of competition and sealed bids, expanding the requirements for cost data for sole-source procurements, and introducing a requirement for price data for all large purchases.

Executive Reorganization

Personnel Programs Under Review

President Carter has established the "Federal Personnel Management Project" as part of his plan to reorganize the Executive Branch. Under the direction of Alan Campbell, chairman of the Civil Service Commission, and Wayne Grandquist of the Office of Management and Budget, the project will establish eight special task forces to study and recommend changes in the government's civil service and personnel systems. The entire spectrum of personnel programs is planned for review.

Job Guide Study

New Handbooks Simplify Maintenance

The Advanced Systems Division of the Air Force Human Resources Laboratory recently completed study of a new series of aircraft maintenance instruction guides designed to simplify maintenance troubleshooting while reducing training time for aircraft maintenance specialists.

It has generally been accepted that technical orders are hard to use during aircraft maintenance operations and that technicians often have difficulty finding the specific information they require.

The new guides are small, four- by eight-inch handbooks of sequential instructions for maintenance and troubleshooting, convenient for use on the flightline or in the maintenance area. Emphasis is placed on providing all the information that the technician requires to do the job in one place and ensuring that it is written in clear and easily understandable terms.

Advantages of the job guides include their small size, their readability, and their understandability. The study showed that the maintenance technicians found the illustrations keyed to specific procedures useful. The inclusion of job preparation information was seen as a method of reducing the time required for some tasks and of contributing to maintenance safety.

One disadvantage found during the study was that for some maintenance tasks, technicians had to use too many volumes. Sometimes, too, they had difficulty locating specific information quickly.

The study findings will be used in the preparation of future guides.

$25,000 Incentive Award

President Honors Federal Employee

President Carter recently presented a $25,000 incentive award to Lawrence L. Guzick, head engineer in the Aircraft Carrier Ship Logistics division of the Naval Sea Systems Command.

Mr. Guzick won the award for his invention of an orifice and filter assembly which replaces the conventional steam trap used on naval ships since early in the development of steam-powered equipment. The device, which has been approved for fleet-wide installation, improves the reliability and availability of steam-machinery systems, reduces steam leakage, and improves turbine and thermal efficiency of the entire power system of steam-powered ships. The Navy anticipates annual fuel and maintenance cost savings of over $10 million from Mr. Guzick's invention.

The $25,000 award—the maximum that can be granted—was conferred on only five previous occasions since the Federal Incentive Awards program was established in 1954, and never before by a President.

Feedback

To the Editor:

The article "Tracking the Costs of Depot Maintenance" (July 1977) stated that on October 1, 1976, the Army and Navy implemented the depot maintenance cost accounting system prescribed by DoD 7220.29H and that the Air Force plans full implementation by October 1979. Taken at face value, these statements could lead one to conclude that the Army and Navy have fully and successfully implemented the DoD cost accounting system while the Air Force has not implemented any portion of it. Such conclusions would not be valid.

The following information is provided to supplement the text of the article and to correct any erroneous conclusions which might have been drawn since it was published.

The Defense Audit Service reports the Army and Navy have not fully implemented the DoD depot maintenance cost accounting system. In a July 26, 1977 draft report, the DAS stated the "system was not fully implemented within the 11 Army maintenance facilities." Further, the "system was not fully and uniformily implemented at Naval Shipyards." Even at the Naval Air Rework Facilities, in which the "Handbook was generally implemented," the DAS identified several areas requiring additional attention.

In July 1977, the Air Force completed implementing an interim depot maintenance uniform cost accounting system which includes most of the handbook requirements. The one major requirement with which Air Force does not comply is the requirement to collect actual hours identified to individual job orders. DoD has waived this requirement for the Air Force pending Air Force acquisition and implementation of an on-line automated source data collection system.

The Air Force supports the principles of uniform cost accounting and will continue its efforts to comply with DoD 7220.29H.

F. M. ROGERS
General, USAF
Commander, Air Force
Logistics Command

Mr. Jivatode, the author, replied:

The article was not intended to imply the Air Force had not implemented any portion of the DoD Uniform Depot Maintenance Cost Accounting System. The statement was that the Air Force plans full *implementation by October 1979. The other Military Services had scheduled full implementation for October 1, 1976. The author was instrumental in initiating the Defense Audit Service review to determine the degree of implementation actually experienced by all Services. At the time the article was submitted for publication the results of the audit were not available nor had the Air Force implemented its interim system.*

Full implementation of this system will be largely dependent on the attitude toward it and emphasis placed upon it by the senior officials involved. General Rogers' expressed interest and support is demonstrative of what is required for successful implementation.

Hot Reading for a Cold Winter's Day

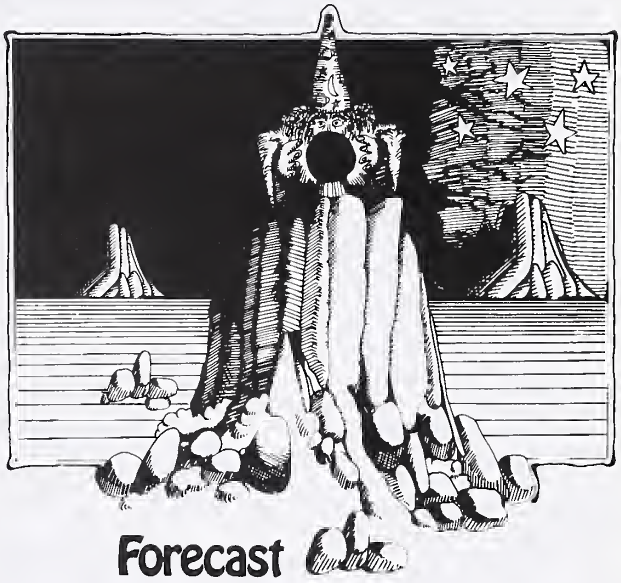
It will come as no surprise to regular readers of the **DMJ** that this issue marks the passing of an era. As heralded, the **Journal** will become a bimonthly publication with its January 1978 issue. Still, excluding the change in publishing frequency, will anything really be different? We think so.

In our next issue, contributors will range from a Navy lieutenant to an industry vice president, from an Army systems manager to a United States Senator, and from a group of professors to a rear admiral. And the subject matter is as diverse as the experience of the authors. But the proof of the talent is in the articles' reading.

While jokes about a changing role for women in the military abound, we all know that this is no laughing matter. Recently the quality of our recruits has been seriously questioned, and one of the most viable options for allaying this problem seems to be utilizing the fair sex more effectively. Reporting on a case study of Navy tugs, Lt. John E. Kane analyzes some of the fundamental managerial problems involved when women are assigned to a traditionally all-male environment. Although the problems are essentially predictable, some of the solutions may make you reconsider how firmly grounded your own management and leadership skills are.

In 1973, a Presidential Memorandum made management by objectives the official administrative policy of the federal government. However, reported results about the effectiveness of MBO have been spotty at best. Accordingly, an interdisciplinary research team of professors from Virginia Tech was hired to ascertain if MBO is a feasible technique for directing the scientific work in a typical research and development facility. They discovered that, while most federal agencies use MBO primarily to control middle management's execution of programs, enormous advantages can be gained from a program- and people-oriented MBO which permeates the **entire** organization. Solid research by a group of true professionals earmarks this enlightening reading.

An equally worthwhile message can be found in Col. John C. Bahnsen's candid article on the Army's total system development approach. Using a 1976 Army study critical of the service's integration of personnel, logistics, and training requirements on anti-armor weapon systems, our outspoken author offers a logical alternative and discusses simulation as a key approach to improving the Army's readiness posture in a cost-effective manner.



The word from the pressure-packed world of Capitol Hill is that DoD has indeed been a leader in management. Colorado's Senator Gary Hart, an industrious member of the Armed Services Committee, has proposed legislation that would make life cycle costing an everyday term in today's energy-conscious America. In his article, Senator Hart calls on the Defense Department to share its wealth of knowledge and experience with the public and other federal agencies. Read the article and you'll agree: it's time to heed the call.

This is but a small sampling of the wide variety of subjects covered in the inaugural bimonthly issue. There will also be articles on what the Navy has learned in its efforts to incorporate zero-base budgeting, and a contractor's successful method for operating a management system dedicated to the maintenance of mature and out-of-production military hardware. Plus our standard departments on short informational items, of course. There should be something for everyone.

So next January, as you warm your chilled body before the family fireplace (or huddle in your office beseeching the gods of the heating vent), warm your mind with a few hot management articles. Pass the word: you'll find them in the new **Defense Management Journal.**

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CALENDAR

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Critical Path Method: Project Planning and Control	Oct. 29-Dec. 17 (Saturday mornings)	Washington, DC	Director, Continuing Engineering Education George Washington University Washington, DC 20007 (202) 676-6106
Government-wide Requirements for Performance Measurement Systems—for contractors and managers	Nov. 2-4	Washington, DC	AIIE Seminars P.O. Box 25116 Los Angeles, CA 90025 (213) 450-0500
Seminar: Application and Tailoring of Specifications and Standards	Nov. 8-10	Monterey, CA	T. L. Golmis, Industry Coordinator Hughes Aircraft Company P.O. Box 3310 Fullerton, CA 92634 (714) 871-3232 Sam P. Miller, Government Coordinator DMSSO, Cameron Station Alexandria, VA 22314 (202) 274-6728
Market Forecast: Five years and Beyond—for aerospace, defense, and electronics managers	Nov. 28-29	Los Angeles, CA	State of the Art Seminars, D/MF P.O. Box 92932 Los Angeles, CA 90009 (213) 437-7465
Middle Management Assessment Center—to identify and develop skills	Nov. 28-30 Feb. 15-17	Washington, DC	Leslie Bobrowski/Karen Niles USDA Graduate School 529 14th St., N.W. Washington, DC 20045 (202) 447-3247
Federal Procurement Seminar—for contractors	Dec. 5-6 Feb. 7-8	Los Angeles, CA New York, NY	Heidi Kaplan, Dept. 14NR New York Management Center 360 Lexington Ave. New York, NY 10017 (212) 953-7262
Configuration Management of Software Programs	Jan. 23-25	Washington, DC	see George Washington University above
Zero-Base Budgeting Seminar—for managers and analysts	Feb. 1-3	Ann Arbor, MI	Division of Management Education The University of Michigan 1735 Washtenaw Avenue Ann Arbor, MI 48109 (313) 764-1817

defense management JOURNAL

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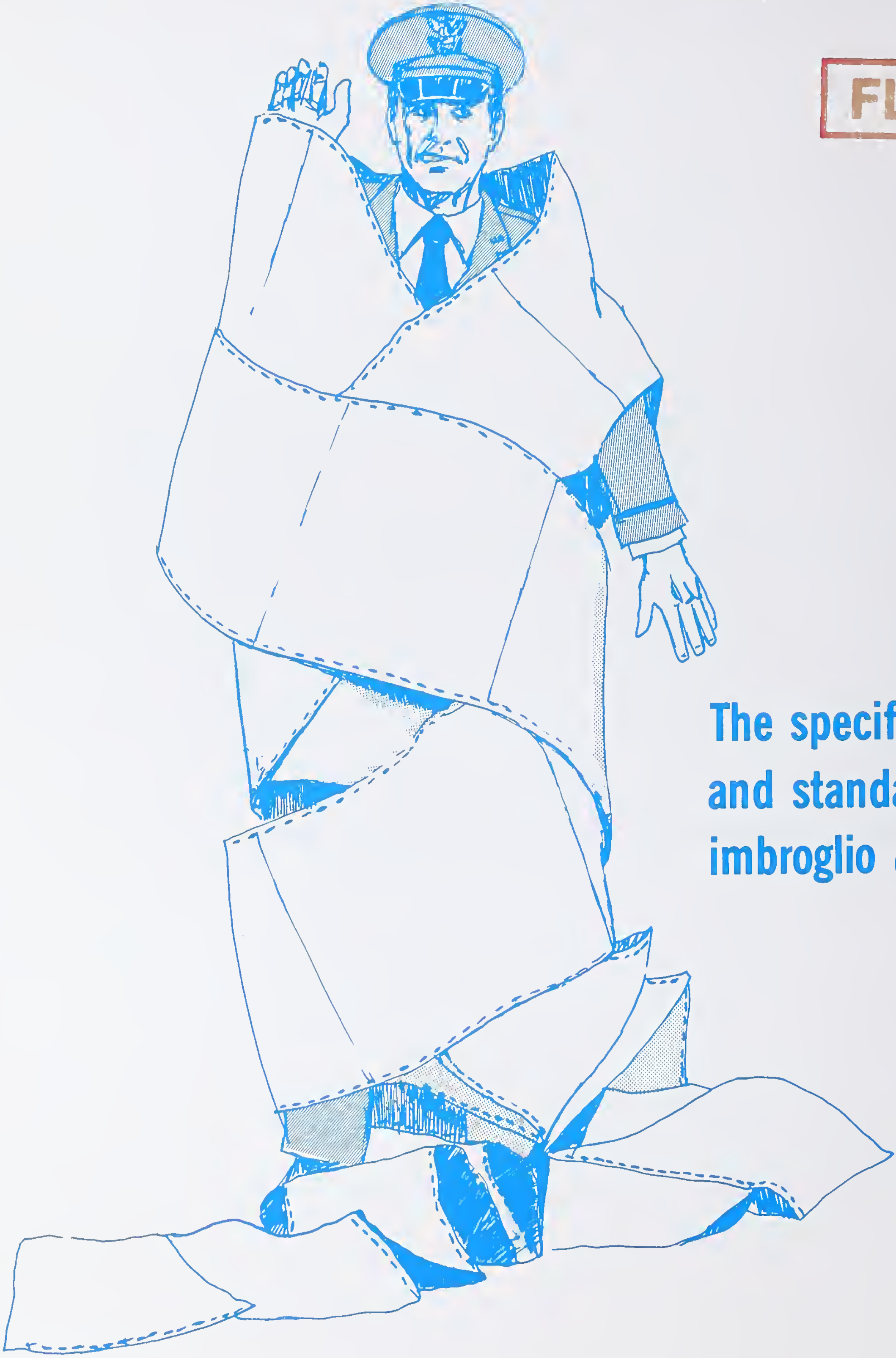

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